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ECONOMIC GEOGRAPHY

JANUARY

AGRICULTURAL REGIONS OF SOUTH AMERICA
Clarence F. Jones, *Economic Geographer*, Clark University

THE POTATO INDUSTRY IN NEBRASKA
Esther S. Anderson, *Geographer*, University of Nebraska

AGRICULTURE IN THE DRY REGION OF THE U.S.S.R.
N. M. Tulaikov, *Director*, Agricultural Experiment Station, Saratov

THE GERMAN SUGAR BEET INDUSTRY
E. Muriel Poggi, *Geographer*, University of Illinois

DIVISIONS OF THE PINE FOREST BELT OF EAST TEXAS
William T. Chambers, *Geographer*, Stephen F. Austin State Teachers College

ARK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.A.

OUR CONTRIBUTORS

Dr. Jones, professor of economic geography at Clark University, in Instalment VII of the *Agricultural Regions of South America*, concludes the series of articles on South America. The materials on the agricultural regions of South America, somewhat revised, are soon to be published in book form by Ginn and Company.

Miss Anderson, who is instructor in geography at the University of Nebraska, now on leave of absence for graduate work at Clark University where she hopes to receive her Ph.D. degree in June, 1930, has done extensive work in this field, and has contributed several interesting articles to various geographic magazines, the latest being "Nebraska," to appear in the revised edition of the *New World Encyclopaedia.*

Dr. Tulaikov, who contributes an article on the "Agriculture in the Dry Region of the U. S. S. R.," is director of the Lower Volga (formerly Saratov) Regional Agricultural Experiment Station and is in charge of the Division of Field Husbandry. Formerly, he was chairman of the Agricultural Scientific Committee, which is now being called the State Institute of Experimental Agronomy. Most of his larger works are published in Russian, although several on the agriculture of the dry area of the U. S. S. R. have appeared in English, American, and other European publications, some of which are "The Genetic Classification of Soils," in the *Journal of Agricultural Science*, Volume 3; "Drought and the Means of Overcoming Its Evil Effects in the Volga Region of East Russia," in the *Journal of the American Society of Agronomy*, Volume 15, w. 1; and "The Utilization of Water by Plants Under Field and Greenhouse Conditions" in *Soil Science*, Volume XXI, w. 1.

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SUGAR

SUGAR has become one of man's best foods. Its nutritive value, its concentrated form, its wide adaptability to use with other foods, its relative ease and low cost of production, the variety of sources from which it may be obtained—all these combine to make it almost indispensible in man's economy as well as in his dietary.

"A land flowing with milk and honey" was man's early ideal of a desirable homeland as soon as he had become a pastoralist or a farmer; and this ideal is essentially unchanged in the highest civilization of today, except that for the sweetness of honey man has substituted the sweetness of sugar. The early man knew nothing of sugar but he did know of the rich sweetness stored in the wild bee's hive, and the milder sweetness of the juices of some trees and fruits and canes and roots. Few indeed there were who did not seek, and find, some form of sweetness for part of their food. The civilized man draws upon all these sources and his consumption of sugars has increased hundredfold over the earlier man's happiest dreams.

From tropic isles he draws vast stores of cane syrup and sugar—Cuba, Hawaii, Java, the Philippines—wherever the sun is warm, the waters are plentiful, and the soil is tillable. From temperate plains he draws other great stores of beet sugar—from the black soil stretches of Europe, of America. From cooler lands he draws the sweet sap of the maple tree, most aromatic of all. A great industry has grown up in the production of these sugars, in their manufacture and their distribution; an industry that modifies the economic and political life of all the civilized peoples of the world. Almost, the stage of a people's culture, its progress and activity, may be gauged by its consumption of sugar.

Honey has not lost its savor, its strength and health-giving virtues. The honey of the Judean hillsides is still eagerly sought; the honey of Hymettus still flows sweet and satisfying; the logwood honey of Jamaica, the white clover honey of the American prairie pasturelands, the wild sage honey of the Southwestern arid plains, the sourwood honey of the Carolina mountains, the tupelo honey from the Southern bayous—all these enter the world's trade and find their friends among epicurean palates. But the world's bees can no longer satisfy the needs of the world's busy men for sugar foods, and the cane and the beet hold first place in civilization's larder!

ECONOMIC GEOGRAPHY

Vol. 6 JANUARY, 1930 No. 1

AGRICULTURAL REGIONS OF SOUTH AMERICA

Instalment VII

Clarence F. Jones

Economic Geographer, Clark University

North Andean Crops and Grazing Region

FROM near the southern border of Colombia in the great Pasto Mountain knot, the North Andean Crops and Grazing Region stretches to the north and east for 1,400 miles, ending in the mountainous peninsula of Paria. Bordered on the west by the Pacific tropical forest and on the north by the tropical forests of the lower Cauca and Magdalena Valleys and the Maracaibo Lowland, by the arid plateaus of Barquisimeto, and by the Caribbean, it bridges the Cordillera ranges and valleys, extending down the eastern flanks of the Eastern Cordillera to the tropical forests in Colombia and to the savannas of the *Llanos* in Venezuela. Though a narrow region, for the most part, it embraces by far the most important agricultural sections of both Colombia and Venezuela. It has a large part of the cultivated land of the countries, a goodly share of the stock, and in addition to a large variety of subsistence commodities, produces the principal commercial crops of the two republics. Within its confines are the chief concentrations of population, the chief cities, and, except for the lower Magdalena, the major transportation facilities. Yet, most of the area depends upon pack animals for the movement of produce to railway and river from isolated mountain recesses and deep valleys.

Physical Conditions

Variety of physical conditions characterizes the North Andean Region; few areas in South America exhibit such sharp contrasts within short distances. At places there are deep fertile humid tropical valleys with lazy mulatto; at others, hot gorges supporting only cactus and thorny growths; on the steep humid slopes the deep green of the coffee *fincas*, carefully tilled by the industrious highland mestizo; higher up, clothing many a steep slope, the patchwork of temperate cereals garnered by struggling highland Indian; verdant grassland slopes and summits dotted with the huts of the pastoralist; the cold cloudy *paramos* with their heath-like and resinous plants and *ichú* grass,

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and above all the eternal snows of the towering Cordillera.

RELIEF

The major relief features of the north Andean Region include the three ranges of the Cordillera in Colombia, separated by the deep Cauca and Magdalena Valleys and the Eastern Cordillera, which extends northeast, skirting the Caribbean in Venezuela. Extremely rugged, these ranges, in contrast to those in the Central Andean Crops and Grazing Region, enclose few high broad pampas or plateaus. For the entire area few level stretches of any extent exist and they do not constitute the chief agricultural lands. The western part of the region is marked by the bold, high, Western Cordillera, affording few low passes. This range drops off sharply to the Cauca Valley, about 15 to 25 miles wide, 150 miles long, and from 2,500 to 3,500 feet above sea level. North of Cartago the mountains hem in the valley which becomes a mere ribbon between huge walls of sandstones and shales. From its rolling to flat surface the land to the east rises rapidly in places in rounded hills, and in others in steep valleys to great heights in the Central Cordillera. This range occupying a vast extent of land consists of a great north-south backbone with peaks rising to more than 18,000 feet. Its flanks deeply carved by numerous tributaries of the Cauca and Magdalena support a fairly dense agricultural population especially the western slopes from 3,000 to 9,000 feet. The Upper Magdalena from 1,000 to 3,000 feet above the sea, like the Upper Cauca, has stretches of level lands, but mountain spurs come to the river's edge in many places. In the broad eastern range of mountains a few high plateaus or savannas afford stretches of level land; among these the important ones are the Savanna de Bogotá, a level plain about 30 miles wide and 75 miles long and 8,700 feet above the sea; the Sogamoso, much smaller and only 8,200 feet above the sea; and in Venezuela, the Valencia Basin, about the size of the Savanna de Bogotá, and approximately 1,500 feet above sea level. But most of the Eastern Cordillera, from the southern border of Colombia to the forested head lands of the Paria Peninsula, consists of high mountains and deep valleys, whose moist slopes provide the chief farming lands of the eastern part of the region.

CLIMATE

Corresponding with relief and altitude are marked contrasts in climatic conditions. Four temperature zones based chiefly on decreasing temperatures with altitude include (1) the tropical zone, up to near 3,000 feet, where the mean annual temperature is from 83° to 75° F. with little range from month to month; (2) the subtropical to temperate slopes and valleys from 3,000 to 6,500 feet or thereabouts, with mean temperatures of 75° to 63° F.; (3) the temperate lands of high plains and mountains from 6,500 feet to near 11,000 to 12,500 feet, with mean temperatures from 63° to 50° F.; and (4) the *Paramos* and snow-capped Cordillera above 11,000 to 14,500 feet, cold windy regions all of the time. The altitudes at which these climates are found vary considerably with latitude, exposure, and meteorological conditions, but within ten degrees of the equator they are quite fixed and accepted as fair approximations to the truth (Fig. 123).

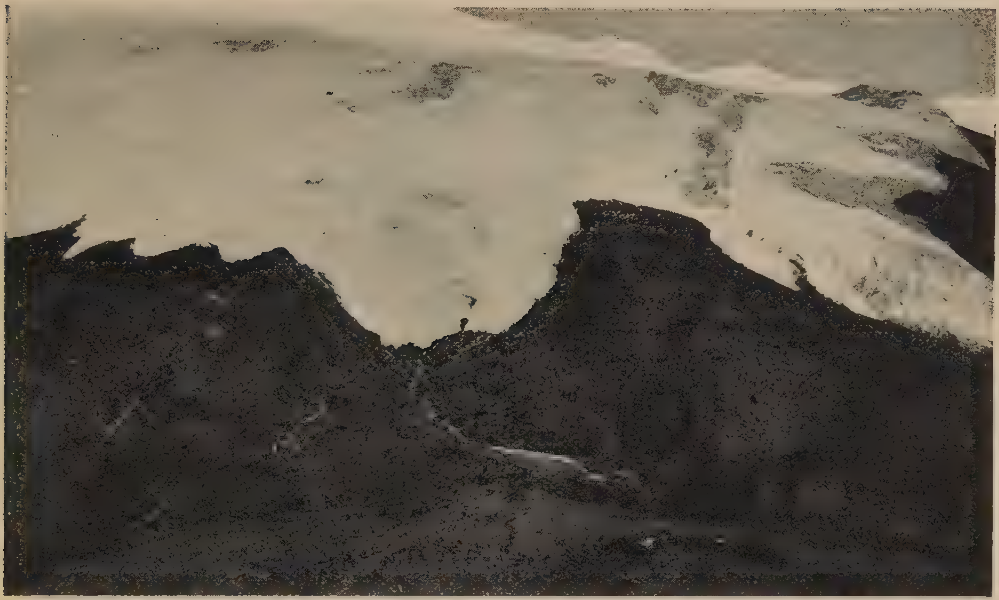

Figure 123.—The Central and Eastern Cordilleras have considerable areas of high *paramos* and snow-capped mountains, areas utilized only for a little summer grazing; El Ruiz, 14,700 feet. The slopes below the glacier support a very sparse vegetation.

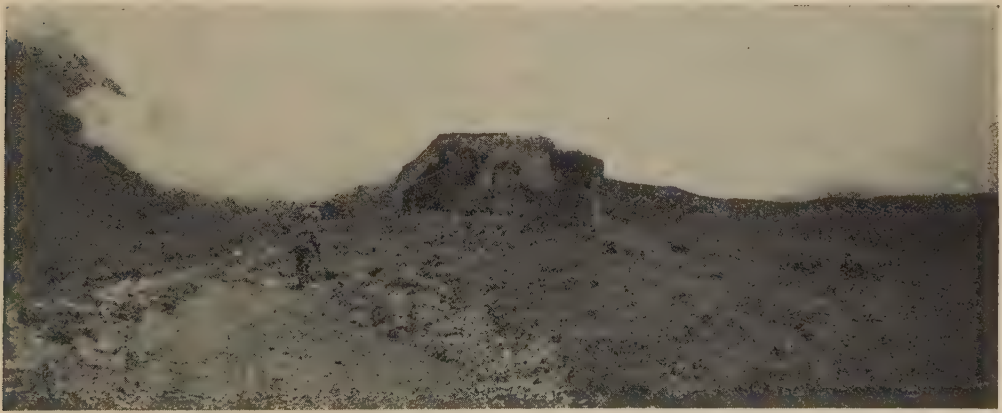

Figure 124.—In the Eastern Cordillera, one day's ride south of Pamplona. Temperate grazing lands on the lower edge of the *paramo*, 11,500 feet. In the distance, typical cold clouds and mists rolling up the valley.

For the region as a whole precipitation ranges as much as temperatures. Exposed slopes at intermediate elevations receive large amounts in heavy convectional showers. Deep, narrow sheltered valleys and lowlands along the Caribbean receive almost no rain, exhibiting desert flora. Except for the portion of the region bordering the Caribbean, there are two rainy seasons at the time of maximum elevation of the sun separated by two seasons of little rain. In the northeastern part most of the precipitation comes in one long season from May to October inclusive. But exposure and altitude cause large contrasts. The eastern slopes of the Western

Cordillera and the flat floor of the Cauca Valley, exhibiting dry conditions, receives from 30 to 40 inches of rain per year. The western flank of the Central Cordillera from Medellin to Popoyan at 4,000 to 7,000 feet receives a rather heavy precipitation from 45 to 75 inches and possibly a little more in places. In precipitation the middle Magdalena presents a close parallel to that of the Cauca and the bordering ranges. Within the eastern range the broad savannas and basins receive a medium amount of precipitation; Bogotá (8,727 feet) 40 inches, Valencia (1,800 feet) 51 inches, and Caracas (3,420 feet) 32 inches (Fig. 124).

VEGETATION

From sheltered valley to bold slope everywhere striking contrasts of precipitation show similar contrast in crops and vegetation. Along the Caribbean coast a sparse growth of zerophytic forms, cactus, acacia, dividivi, algarroba, and others change gradually with elevation to a heavier forest growth high on the flank of the mountains. Over the divide of the northern range the southward-facing slopes are chiefly grass-covered, except for strips of trees along the ravines. The level floor of the Valencia Basin, where not in crops, consists of savanna lands—tall grasses interspersed with several species of trees. Numerous small sheltered valleys within the region have desert-like flora, but the two large areas of semiarid vegetation include the Upper Cauca and the Upper Magdalena Valleys. Here, forests are largely restricted to the banks of streams and low-lying areas; over much of the surface the grasses and bushy thorny growths show plainly their adaptation to drought. Everywhere at lower elevations in moist places are true tropical forests which extend up to near 3,000 feet. A subtropical forest clothes the slopes from 3,000 to near 6,800 feet including many tropical species as well as tree ferns, oaks, and walnuts, and in the *Inga* the valuable coffee shade tree. This subtropical forest grades into a temperate zone of good timbers where plenty of moisture is available, this in turn giving way, from 8,000 to 9,000 feet, to the cold grasslands, which are replaced by the bleak *paramos*, areas of hardy grasses, mosses, ferns, the woolly *Espeletia*, and some sprawling shrubs (Fig. 125). Belonging to the better

Figure 125.—The tall tree fern reaches its best development in the subtropical forest on the intermediate slopes of the Cordillera.

FIGURE 126.—In the coffee region of the Central Cordillera. The coffee trees are well cared for, being pruned properly and sometimes intertilled. Near the upper border of the coffee zone at 6,000 feet little shade is required. In this picture the shade trees are *inga*. Excellent coffee is produced on the well drained soils of these humid valleys.

temperate grasslands are the intermontane savannas, the most important of which is the Savanna de Bogotá; its vegetation consists chiefly of temperate grasses, only two trees, an oak (*Querces Humboldtii*) and the eucalyptus being present in numbers. The latter tree, introduced several decades ago, now lines all the farms, fields, roads, and even the streets in the villages on the savanna.

AGRICULTURE

Throughout the North Andean Region, like the physical conditions, farm lands, crops, and animals show striking variations within short distances. The region produces almost the entire list of tropical and temperate products, but only a few have risen to commercial significance. Coffee and cacao are shipped to foreign countries in large quantities, the products being the financial backbone of both Colombia and Venezuela, until replaced by petroleum in Venezuela. While grown almost entirely for local use, some produce within the region moves from valley to mountain, from tropical to temperate climes, and vice versa, though, in general, the distances covered by any commodity are not great owing to general zonation of crops with rugged relief and the inadequate transport facilities.

FIGURE 127.—A coffee drying floor in the Sierra Nevada de Merida of Western Venezuela; near San Cristobal. The coffee bushes at the lower altitudes in this region are well shaded by *inga* trees.

COFFEE

Coffee dominates agriculture in much of the North Andean Region. Though occupying but a small per cent of the total area, it is widely dispersed in the highland valleys from 2,000 to 6,500 feet, the better coffee coming from the middle and upper portion of this zone. The chief areas of production include (1) the western flank of the Central Cordillera from Medellín south to Popoyan, (2) the western flank of the Eastern Cordillera from Ocaña south to Neiva, (3) the northern valleys of the Eastern Andes from Pamplona in Colombia to East of Caracas in Venezuela, (4) the deep valleys within the Eastern Andes in Venezuela, including portions of the Lake Valencia basin, and (5) smaller areas on the eastern flank of each of these ranges where moisture and other conditions are favorable (Figs. 126 and 127).

The significance of coffee culture in the agricultural economy of the region results in a large measure from auspicious physical conditions. Most of the coffee plantations occupy regions of rugged relief, but the steep slopes, often of 25° to 30° angles, in deep valleys, provide the free movement of soil moisture so essential to the coffee tree. Also, these deep valleys are sheltered from desiccating winds and strong winds that would break heavily laden trees, where they are not pruned. On these slopes red fertile soils high in potash and iron and several feet deep aid in producing good yields. Temperatures ranging from about 58° to 78° F. are most favorable; on the lower hot slopes large strong berries grow, trees require much shade, and considerable attention; higher up trees yielding smaller and milder berries, require less shade and only a fair amount of attention, but they have a shorter life. Although varying greatly, the annual rainfall of from 40 to 70 inches in normal years is well distributed for the proper flowering and fruiting of the plant and for harvesting and drying the berries. During the rainy season mists and clouds drift up the valleys in the hottest part of the day and drench the coffee trees with a convectional shower and shelter them from the hot rays of the noonday sun. A combination of these physical conditions and good methods of preparation give to Colombian and a small part of Venezuelan coffees their distinct qualities; as mild coffees, valuable for blending, they contain a large proportion of essential oil, low weight of ash, high caffein content, great density, and uniform green color of berries.

Plantations in size and in number of trees vary greatly in different parts of the region. Most of the coffee *fincas* in Venezuela embrace considerable areas, but in the western portion several small holdings exist. In Colombia the average plantation has about 9,000 trees; only about 225 contain more than 100,000 trees; the great majority have less than 5,000. In the region on the western flank of the Central Cordillera the small coffee producer dominates. Here, small plantations are owned by individual farmers who, with large families, take care of all the work of the plantation. This section produces the best-quality coffee and the greatest yield per tree.

As with the size of plantations, the region exhibits marked contrasts in methods of culture. On only a few of the large estates of Venezuela do modern methods exist. In general, the coffee tree, never pruned, grows from 10 to 14 feet high, and has a large number of non-bearing branches; the yields of unpruned trees decrease rapidly after a few years (the average yield for Venezuela being less than one-half pound per tree per year according to H. Pittier). Other poor methods include: no seed selection, new plantings being made from seedlings that spring up under trees from dropped berries, no fertilization, too much shade, no attempt to cope with diseases and pests, and the picking of both green and ripe berries from a branch with one stroke of the hand down the branch, destroying many of the new buds at the same time. These same methods exist in the portion of Colombia adjacent to Venezuela, but there efforts are being made to improve conditions. In other parts of Colombia methods of tillage and preparation compare with those in the best coffee regions of the world. Trees are planted systematically at distances of about five feet on fertile soil or 8 to 10 feet on less fertile soil; shade trees of *pisquin* (*Erythrina edulus*) and *guamo* (*Inga vera*, *I. sapida*) are placed at 35 to 50 feet, distance varying with altitude. The land is tilled once or twice a year. In spite of a labor shortage only ripe berries are picked; two pickings a year in most sections yield from one-half pound of cleaned coffee per tree per year to one and three-quarters pounds in the better districts of Antioquia. At the same time a far better-quality berry is the result (Fig. 128).

The industry labors under other handicaps. Owing to attractive work and wages in construction units and the oil industry and to the ease of life in some sections, there is always a shortage of labor which often becomes acute at harvest time. Recent estimates place the portion of the crop lost, for want of laborers to gather it, at 15 per cent of the total. Just before the harvest, urgent calls for laborers are posted in frequented places in all Andean recesses. Few immigrants come to these parts. When gathered and prepared for shipment the coffee meets high freight rates to the coast, except for portions of Venezuela near the sea; in other sections months may elapse before the crop reaches ocean shipping (Fig. 129).

The region as a whole can witness considerable expansion of the coffee industry. Many virgin slopes only await planting to produce abundant crops. As trails, highways, and railways are completed, many areas can increase the output, providing sufficient labor can be procured and a world market can consume the surplus.

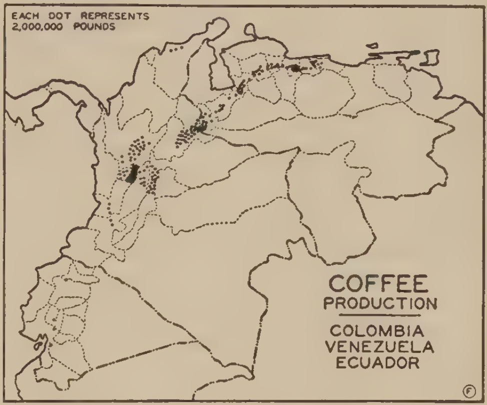

Figure 128.—All the coffee districts of the North Andean Crops and Grazing Region occupy rather rugged steep slopes at intermediate elevations. (From "Commerce of South America," C. F. Jones. Courtesy of Ginn & Company.)

CACAO

More exacting than coffee in its physical requirements and necessitating much time, labor, and careful preparation of the bean, cacao occupies much less land than coffee. The chief areas of production include (1) the Coast Range of Venezuela from west of Puerto Cabello to Carenero and inland in the deep valleys to the south of Caracas; (2) the lower levels of the Andes to the southeast of Lake Maracaibo in

Trujillo, Merida, and Tachira; (3) the Middle Magdalena Valley especially in Ocaña; and (4) small patches in the Upper Cauca Valley. In these areas the plantations occupy the level narrow valley floors of alluvial clay loam soils and extend up the slopes on heavy red clay soils to elevations of 3,000 feet or somewhat higher. Constantly high temperatures; a rainfall of 40 inches or more, usually more; prevailing high humidity; the absence of desiccating winds; and good drainage determine the specific areas to be selected for cacao culture.

Though conditions of culture vary considerably from one district to another, in general, from 200 to 250 trees are planted to the hectare, large virgin forest trees being left for shade instead of being planted as on the better-managed coffee estates. While trees are young, corn or other subsistence crops may be grown between the rows. Once in bearing the trees receive little or no attention except for the gathering of the crop. As compared with coffee, cacao requires more care in preparation and shipping, the product being delicate and subject to fermentation, mold, and damage from dampness and heat. Diseases, especially the diseases occasioned by the gray moth and black pod rot, and the cacao beetle do much damage. Several varieties are grown, but little attempt is made to sort and grade the beans. Since the cacao bean cannot be stored for considerable time in hot humid area, the meagre transport facilities in remote sections hinder greatly cacao culture. Also, the shortage of labor in all areas retards expansion.

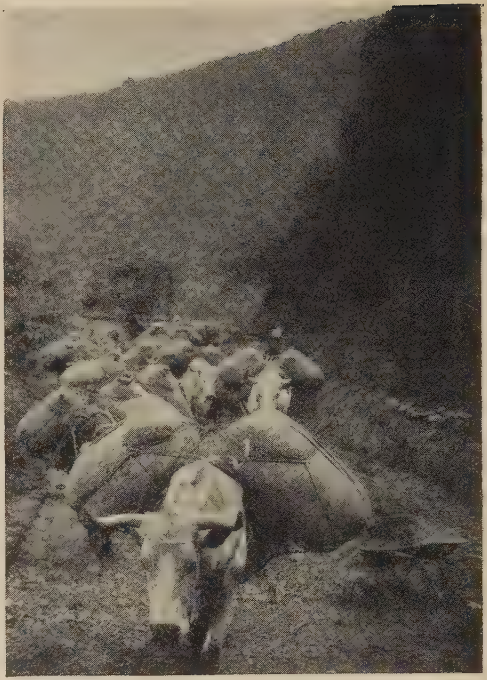

Figure 129.—Sacks of cacao being transported from the Cauca Valley to Medellín, whence they move by rail and the Magdalena river to Puerto Colombia for export. In parts of the North Andean region cattle are the chief pack animals.

COTTON

Of minor importance commercially, cotton has been grown for a long time in different portions of the region, especially in (1) the Valencia Basin and the dry valleys near Caracas, (2) in the department of Tolima and Boyaca in Colombia, and in the Upper Cauca Valley. In all these areas fertile clay and sandy loam soils, fairly large areas of level land, a long rainy season followed by a dry sunny harvest period, and high temperatures favor cotton culture. The fibers produced are fairly long and of good quality, but badly colored and mixed; in the Cauca Valley area a half a dozen different varieties grow in the same field; no attempt is made to grade or standardize them. Though the terrane would allow the use of modern machinery, only a few are employed on the large plantations. Some of the cotton consists of the annual varieties, but much of it is perennial. At present a great deal of the cotton grows on large plantations, with corn and beans between the rows as supplementary crops. Often these crops pay for all the labor on the plantation, except for the picking. Owing to shortage of labor at picking time, and careless methods, as much as 20 to 25 per cent of the crop may be left in the field. As with other crops, insect pests and diseases do much damage and nothing is done to restrict their ravages. Considerable areas possess the physical requirements for cotton culture, but many improvements in seed selection, planting, tillage, picking, and grading must come before the region ranks high as a cotton area.

SUGAR

More widely distributed than either cacao or cotton, sugar constitutes an important crop in most sections of the North Andean Region up to 6,000 feet elevation. Grown on nearly all large cacao and coffee estates, it occupies considerable area on a few *haciendas* producing nothing but cane and its products, especially in the Valencia Basin, the Cucuta Region, numerous small arid valleys in the Eastern Cordillera where water is available for irrigation, and in the Magdalena and Cauca Valleys. With fertile clay soils and a fair distribution of water, cane grows year after year on the same land without replanting. Records show that cane fields have not been replanted in the last 20 years (in the Cucuta Region and the Medellín Valley), a ratoon crop being cut every 12 to 14 months; some fields have grown cane for 100 years without rotation or fertilization. The cane gets only one or two cultivations with a hoe per season. Consequently the yields of cane and sugar content are low; yields of 5 to 10 tons of cane are considered good in many sections. "*Gomosis*" and "*Mosaic*" infest most areas. Only a few large centrals exist in the whole area; most estates manufacture in a crude small mill the *panela* or the *papelon*, the brown cake sugar so valuable for man and beast; but much of the sugar goes for the manufacture of *chicha* or *aguardiente*, the chief beverage for the laboring classes (Fig. 130).

FIGURE 130.—Below the coffee plantations in the narrow fertile valleys are areas of sugar cane, an important crop throughout the North Andean Crops and Grazing Region up to 6,000 feet above sea level.

TOBACCO

Of long standing, tobacco culture, though carried on in many sections, occupies much less land than the major commercial crops or the chief subsistence products. Tobacco is cultivated in numerous small valleys on sandy clay loam and sandy loam soils in rather small areas at intermediate elevations. In contrast to sugar cane, little is irrigated, the farmers depending upon precipitation for a moisture supply. Tobacco receives more care in cultivation than many other crops. The tender plants, transplanted from nursery beds to well-prepared soil, are cultivated with hoe two or three times a season. But, being grown by small farmers almost entirely, vast room exists for improvement in seed selection, care of the plants at gathering time, drying, curing, and grading (Fig. 131).

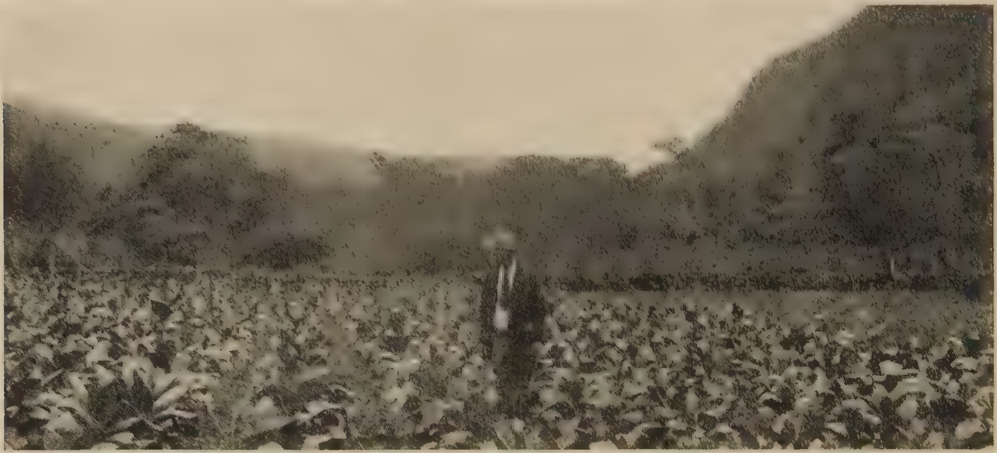
FIGURE 131.—At intermediate elevations tobacco is an important crop in several portions of the North Andean region. With fertile soils and fairly favorable temperatures and rainfall good tobacco is produced. Poor methods of treating and curing, however, yield an inferior product everywhere. Photograph near San Cristobal, Venezuela.

LOW ALTITUDE SUBSISTENCE CROPS

Almost every large coffee, cacao, cotton, and sugar estate has its quota of subsistence crops, including corn, beans, cassava, bananas, and other subtropical products. Also, Indians and mestizos living in remote valleys, away from any large plantations, subsist by the desultory tillage of such crops.

Corn, little used as a feed, constitutes a staple food for the lower and middle classes of the North Andean Region from sea level to 8,000 feet or a little higher; in addition, it serves for the manufacture of quantities of *chicha*. It grows as the first crop on cleared or burned-over lands in the establishment of a cacao or coffee plantation; it does well on steep slopes and poor soil areas, producing big ears of good quality. The brown to black soils of the Valencia Basin, the Magdalena and Cauca Valleys give high yields of fine corn, even without much care. Only in a few of the better-farmed areas is corn carefully tilled; planted in rows varying in width, it may be cultivated in some areas once with a one-oxen wooden plow or with a hoe; in other areas only the weeds are cut out with a machete. Usually pole-beans planted with the corn use the stalk as a support. Cassava often planted between the corn rows serves to keep down weeds and at the same time adds materially to the food supply. Though occupying more land than any other crop, a wide movement of corn is restricted by several conditions; corn has a high percentage of moisture and does not keep well; it cannot be stored more than a few months because of the weevil; transportation costs are prohibitive for such a bulky commodity; many valleys may have a large surplus of corn at harvest time, unable to dispose of it even though corn brings $3.00 per bushel in a highland station 50 or 100 miles away. Only in the form of *chicha* can it traverse distances and yield a profit.

Up to 6,000 feet bananas find a significant place on large and small farms. A few plants near a laborer's hut provide an abundance of starch foods from year to year without any labor; on the coffee estates bananas not only supply the chief food, but in many sections serve as shade for the tender young coffee plants and at the same time keep down the weeds between the coffee bushes. Near large towns more extensive banana fields indicate a commercial production for the urban districts; also, frequently on the trails trains of mules wend their way to highland towns with loads of bananas. Though bananas grow up to 6,500 feet in sheltered places, the size of the plant and the fruit decrease with elevation, those grown at the upper limit being of little value.

TEMPERATE CROPS

Between 6,500 and 7,500 feet a marked change takes place in the agriculture of the North Andean Region. Coffee, bananas, cassava, breadfruit, and other crops give way to wheat, corn, barley, root crops, and vegetables. Though corn grows to nearly 9,000 feet on steep slopes and on stony poor soil, giving good returns, small grains, root crops, and vegetables assume the dominant rôle. Within twelve degrees of the equator the higher parts of the region are areas of temperate agriculture in most respects (Fig. 132).

FIGURE 132.—Above the coffee, banana, and cassava region temperate crops occupy all of the tilled land. On the steep slopes around 7,000 to 8,000 feet corn is an important crop. It does fairly well on slopes of 20 to 30° angle as represented in the photograph. In the highlands of Antioquia near Medellín.

Of long standing, wheat culture engages the attention of most highland farmers. It grows in large areas on the level lands of the region as in parts of the Valencia Basin and the Savanna de Bogotá and climbs high up the steep mountain slopes, especially in the high mountains of western Venezuela, the Eastern Cordillera in Colombia and the high mountains of southern Colombia. In these places the fields of golden grain occupy much of the farm land up to 10,000 feet elevation. Many varieties of native wheat, most of which are resistant, produce a kernel of good quality, but everywhere yields average low, from five to seven bushels; in exceptional places and under unusual conditions 10 or 12 may be obtained. Despite widespread culture, the yields do not supply the demand, imported wheat and flour being consumed in quantities in the region. Local wheat may command a price of

$5.00 per bushel, and still yields remain low (Fig. 133).

At higher elevations and on infertile soils barley replaces wheat in many places and in Southern Colombia *quinoa* retains the position among the crops which it holds in the Andes farther south. As with wheat, the quality of the grain is good, but yields are low, due not so much to adverse physical conditions, but to poor methods of culture.

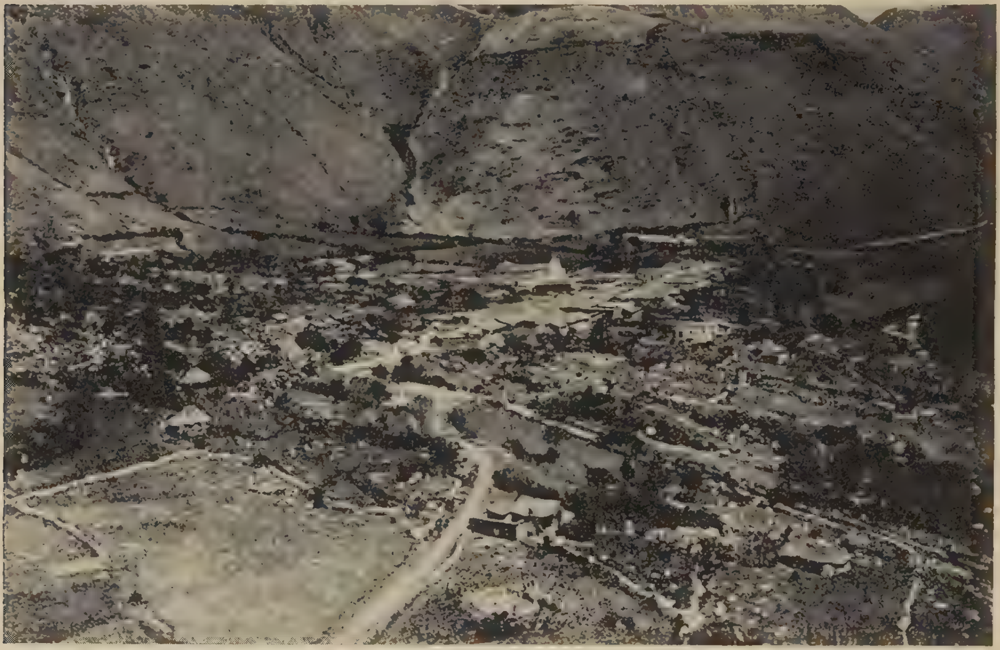

FIGURE 133.—In the Sierra Nevada de Merida, Venezuela. Nestled in the deep valley is a small stagnant town established centuries ago. On the slopes in the distance are the temperate small grains and root crops. In the immediate foreground are patches of corn to the left and in the center a modern threshing floor enclosed by a stone wall. Here animals tramp out the grain from the sheaves as in the days of old. (Courtesy of H. Pittier.)

Throughout the high sections up to near 12,000 feet the Irish potato comes into its own, supplying much of the food for the poor farmer, while *aracacha*, a small tuber, and several vegetables add variety to the diet. They are tilled in small patches on steep slopes adjacent to the houses or where a tiny patch of soil promises a fair yield.

ANIMALS

Cattle, sheep, mules, poultry, and swine find a place in the agricultural economy of the region, the llama, the great burden bearer of the Central Andean Region, and the alpaca, being almost absent in this portion of the highland. Only in high parts of southern Colombia do they graze in considerable numbers. For the region as a whole, cattle and mules are the principal animals, sheep being less important than in the Andes farther south, owing chiefly to the lower elevations of the major concentrations of population. Swine and poultry are kept in small numbers on most estates and small farms; one can always obtain fresh eggs in the most remote sections of the Andes, while boiled chicken all but becomes a national dish.

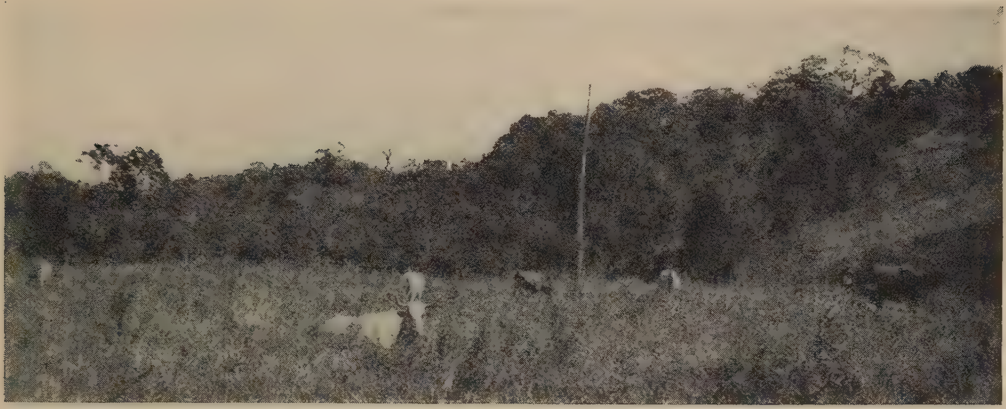

FIGURE 134.—Fine *Guinea* grass pasture near San Cristobal, Venezuela. At the lower elevations *Pará*, *Guinea*, and *La India* are the only important forage grasses for stock. Excellent when young, they become dry and hard in the dry season. In the North Andean Region most of the grasses below 3,000 feet are of these types. (Courtesy of C. E. Cormany.)

Including a number of grasses the grazing lands embrace a significant portion of the entire region; many mountain slopes formerly forested have been cleared and planted to various types of grasses and support many cattle, sheep, and mules. In the low flat heavy clay lands of the Valencia Basin, the Cauca and Magdalena Valleys and many smaller wet valleys, *Pará* grass grows luxuriously; in the same regions only on drier lands two other bunch grasses, *Guinea* and *La India*, replace *Pará*. Excellent forage when young and tender, these coarse bunch grasses become hard and dry each season; *La India* is especially bad for cutting the mouths of grazing animals. These bunch grasses extend, as the upper limit, to elevations varying from 3,000 feet to 4,500 feet depending on soil and moisture. In the Cauca Valley nearly all forage grasses below 2,500 feet belong to these types. In general higher up the grasses consist of *gramma* and many other short grasses that clothe the slopes up to the Paramo with a carpet of green during the rainy season. In some areas in the temperate heights blue grass, orchard grass, and rye grass have been planted, especially on the Savanna de Bogotá, where more than half the area of the level Savanna is in pasture. On the subtropical slopes, 2,800 to 5,000 feet, in the Central Cordillera, especially in Antioquia and Caldas, most of the land not in coffee or other crops has been planted to *Yaragua* grass, a rapidly growing grass, that covers the ground, is almost tick free owing to small globules of oil on the stems, and is an excellent forage; to it Antioquia owes much of its importance in the cattle industry giving high-grade dairy and beef cattle—the *orajo negro*, black ear cattle (Figs. 134 and 135).

In all this territory only three areas have developed a fairly high-grade industry: (1) the Valencia-Caracas area, (2) the Savanna de Bogotá, and (3) the Medellín region of Antioquia. Here some of the animals have been improved by the importation of pure-blood stock in considerable numbers; a dairy industry has developed for supplying the urban centers, but Antioquia has the best cattle industry of the entire region. Many farmers subsist principally on the dairy prod-

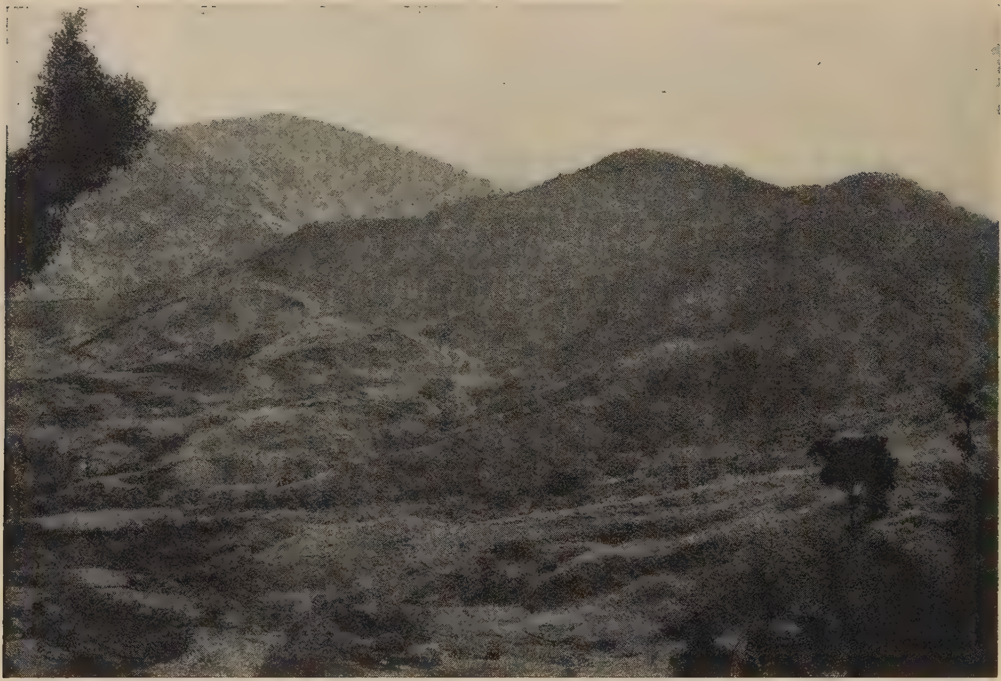

FIGURE 135.—In the Central Cordillera, especially in Antioquia, and in places in the Eastern Cordillera on the subtropical slopes 2,500 to 5,000 feet much of the grazing land has been planted to *Yaragua* grass. It is excellent forage, and having small globules of oil on the stems, it is almost tick free. Highlands near Medellín.

ucts, meats, and hides derived from the herds; most anywhere in this section of the Central Cordillera one can procure along the trail, a fresh glass of milk from the cow's udder. The black ear cattle of this region illustrate what may be done throughout the highland in producing high-grade products (Fig. 136). In all other areas the cattle consist of old *creole* stock; rough bony cattle are used chiefly for draft purposes and pack animals; seldom butchered younger than 4 years of age, they give an inferior quality meat even when fat (Fig. 137).

While the cattle industry reaches its greatest development at intermediate elevations, sheep graze chiefly on the higher pastures, and the *paramo* is almost exclusively their domain. Only in the cool moist areas of the higher portions do they find optimum conditions. But most of the animals consist of low-grade stock, growing only small fleeces of medium-grade wool. Most everywhere the omnivorous "porker," tall, thin, bony, and "long-snouted," roots for a living, though many small coffee farmers have no use for this troublesome animal. Chickens, like swine, pick their own living and are kept by most farmers, being allowed the free range of the patio, and frequently the kitchen and dining-room.

LAND TENURE AND AGRICULTURAL METHODS

Except for the small coffee farmers of the Central Cordillera, in Antioquia, Caldas, and El Valle, most of the land of the North Andean Region is held in vast *haciendas*, the estate being managed by a *major-domo;* the land owner, as a rule, spends little time on the estate, except during the

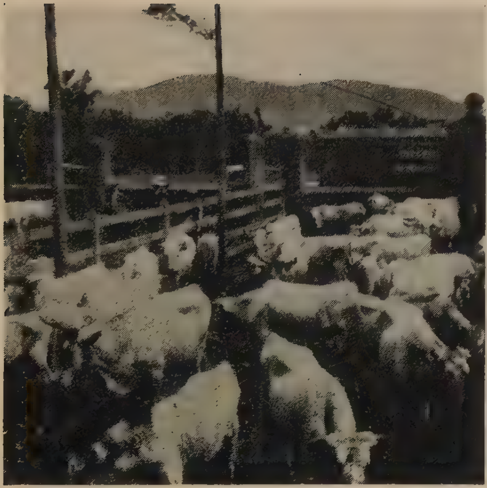

Figure 136.—The black-ear—*orejo negro*—cattle of Antioquia are the best dairy and meat cattle of the North Andean Region. In this area many small farmers subsist primarily on the meats and hides derived from the herds.

planting and harvesting seasons. On each estate the attached laborers, supplied with fenced and cleared land, tools, draft animals, and seed, and subsistence in advance on account, farm an allotted portion of the estate for a part of the produce, usually one-half of the crop in the field at the end of the season; the laborer is paid for assisting in the harvest of the owner's half at day wages or by contract, if he performs this necessary part of the crop labor. This system prevails for most types of farming, but in the extension of coffee or cacao acreage laborers will be given all the produce they can raise from a piece of land, which, after a specified number of years, they will return to the owner in bearing trees. In other cases, laborers, hired outright, work on the estate, buying nearly all the necessaries through the land owners' stores. The productivity of an estate depends in considerable measure on the number of laborers attached to it (Fig. 138).

Figure 137.—On only a few farms in the Savanna de Bogotá have pure bred stock been introduced. Where they are properly cared for they give good results in this temperate region.

With this system of land ownership and tenure, primitive methods persist and crop yields continue low. Only two areas in all the North Andean Region, the Valencia Basin and the Savanna de Bogotá, have improved methods and implements; even here only a few of the *haciendas* possess them. A crooked-stick for a plow, a hoe, and a machete are the universal tillage implements. A number of conditions preclude the use of modern machinery: remoteness from ocean ports, the difficulties of distribution within the region, an illiterate farming class, rough surface of most of the farm lands, absolutely precluding the use of machines, and the unwillingness of land owners to go to considerable expense introducing improved machines which would increase the idle hours of the estate laborers and result in the surplus of a product that could not be marketed, owing to transport difficulties. Except for coffee culture in some areas, the agriculture suffers from other handicaps: lack of any seed selection, absence of crop rotation, no fertilization, ravages of insect pests and

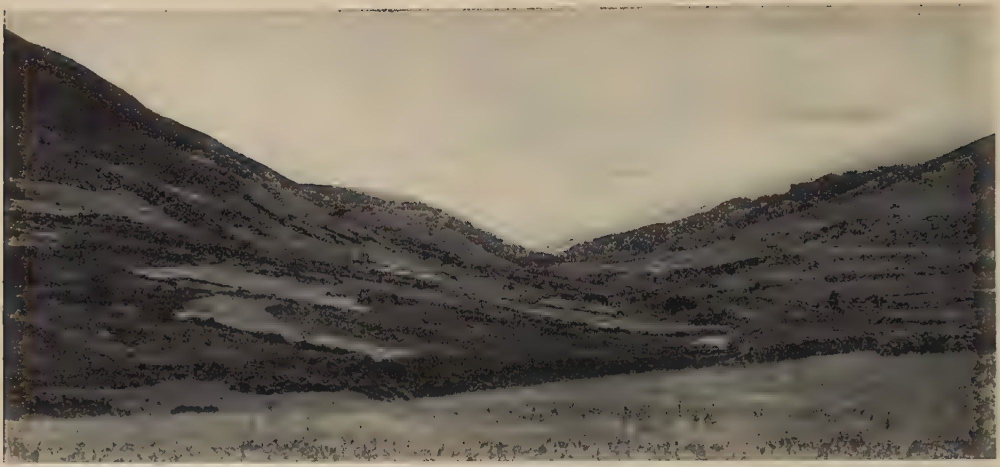

FIGURE 138.—Valley of Rio Chama in Sierra Nevada de Merida. The temperate crop zone; patches of cereals, potatoes, and alfalfa in the middle distance; an excellent field of wheat in the foreground. Elevation 9,400 feet.

diseases, prevalent poor methods of tillage and preparation of products. From estate records, fields in the Pamplona Valley have been in cane for 40 years; others in the Cauca have grown cane for 80 years; in the Savanna de Bogotá wheat has been planted on the same piece of land for 40 consecutive seasons without the employment of any fertilizer. Wheat sown broadcast and cut by hand with a sickle is tramped from the sheaves by oxen or mules on earthen floors enclosed by a stone wall and winnowed by the breezes (Fig. 139).

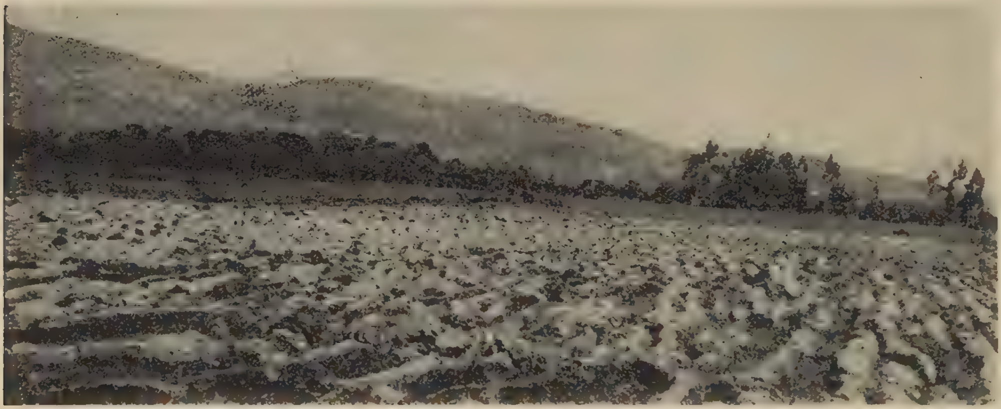

FIGURE 139.—A fairly well plowed field in the level Savanna de Bogotá, an area of temperate crops and grazing. Throughout the North Andean Region most land is very poorly tilled, being only scratched with a crooked stick for a plow and drawn by oxen. (Courtesy of C. E. Cormany.)

In the animal industry poor methods also exist. Though most pastures are fenced with stone or barbed wire, young and old animals graze together, no attempt being made to regulate breeding. The fever tick is present in most areas; yet, dipping tanks are the exception rather than the rule. The warble does considerable damage; other diseases are endemic. Nowhere is milk treated and delivered as certified. It is delivered in the cities by cup dipped from a can on the back of a burro or from a spigot of a can; the milk pails even on good farms, washed in the irrigation ditch or nearby streams, are seldom scalded.

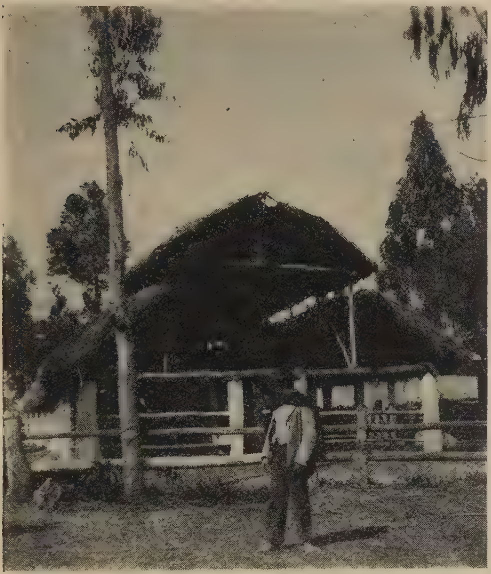

Figure 140.—A modern dairy barn in the Savanna de Bogotá. The tall eucalyptus trees introduced about forty years ago are prominent features of the landscape.

Such conditions were observed as the common practice on a recent survey in many portions of the region (Fig. 140).

The Future

Most of the North Andean Region, permanently handicapped by an inland location and rugged relief, precluding the use of large modern machines in most areas, the region as a whole can advance materially along a number of lines with the improvement of transportation facilities, the rise of the farming class in education and standard of living, and the increase of immigration. Though the region produces excellent mild coffee, virgin lands planted to coffee, better methods of pruning and preparation, and a study of methods of combating coffee diseases will enhance the position of the region in this product. Seed selection and plant breeding, improved methods of tillage, crop rotation, and fertilization are needed in connection with all other crops. Likewise, experiments in breeding the *orejo negro* with the Angus in the Antioquia Highland to produce a breed immune to the warble and the tick, and the native tick-immune longhorn cattle of the lowland with the Shorthorn or Hereford to improve the quality of the meat in the lower warmer regions. But, in the face of all inclinations towards improvement or better methods lie difficult transportation and vast permanent land holdings, tilled by a backward illiterate class that seems, in many ways, incapable of marked advance without a long period of evolution. These conditions will retard for decades agricultural development in the North Andean Region. (Fig. 141).

LLANOS GRAZING REGION

With an area of some 200,000 square miles, the Llanos Grazing Region is the principal grazing land of northern South America. Stretching from the Guaviare River on the southwest to the delta of the Orinoco on the east, the region has a remarkable uniformity in physical constitution and in human economy. It consists essentially of an expansive savanna devoted almost exclusively to the raising of cattle. Though one-third of the land lies in Colombia, from the standpoint of agriculture the *llanos*, or plains, of Venezuela far overshadow the more remote area to the south. Indeed, even explorers have rarely ventured south of the

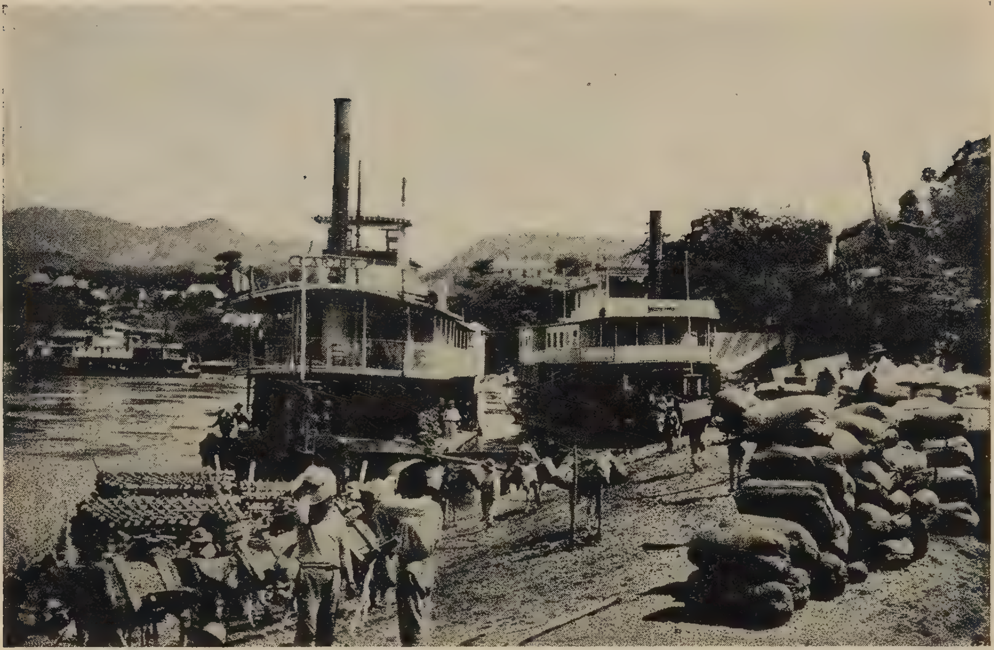

FIGURE 141.—A scene on the Magdalena River showing bags of coffee ready for export, and illustrating the primitive and poor transportation facilities of part of the North Andean Crops and Grazing Region. (Courtesy of the Pan American Union.)

Meta River. Everywhere population is sparse, for these great plains do not conduce to an easy life and their one important industry demands relatively little labor. Access to various parts of the region is easy compared to the hardships of reaching sections of other portions of tropical South America. Both rivers and plains lend themselves to travel, but the land tends to repel large-scale settlement.

PHYSICAL CONDITIONS

The plains of the Orinoco basin composing the Llanos Grazing Region scarcely anywhere reach an elevation of 1,000 feet. Near the bordering mountains and highlands in the north and the southeast, the land rises into rolling hills, but on the average the *llanos* comprise an almost level surface of alluvial materials comparable in point of relief to many parts of the Argentine Pampa. North of the Orinoco River a series of low sandstone mesas furnishes a major relief feature. Soils vary from coarse gravels on the mesas and near the mountains to fine silt loams and clays in the lower more distant portions of the plains. Impermeable clays underlie marshes in many areas, while in others sands and gravels cause droughtiness.

Whereas relief and soils tend to favor agricultural utilization, climate definitely limits possible development. Though the seasonal differences which have caused the establishment of savanna vegetation thereby favor grazing, at the same time they constitute the principal obstacles to the industry. While the annual rainfall averages between 30 and 50 inches in one season—"winter," April to October—floods threaten the region; in the other season—

"summer," November to March—the *llanos* thirst under a blazing sun. Warm throughout the year, in the dry season particularly, the plains experience terrific heat, slightly alleviated now and then by the persistent northeasterly trades (Fig. 142).

The drought of summer gives predominance to the widespread cover of tall coarse bunch grasses and establishes the savanna character of the region. The alluvial plains of the Apure River possess a more favorable stand of grasses and here has grown the principal grazing district of the region. Only along water-courses and in rather large humid depressions to the west and north do trees find growth possible. Among the arborescent forms, two palms prove highly valuable to the native population. The northern plains have *Copernicia tectorum;* the south profits by its supply of *Mauritia flexuosa*. The former tree furnishes abundant material for thatching buildings, as well as for the making of straw-hats, the latter both thatching and construction supplies.

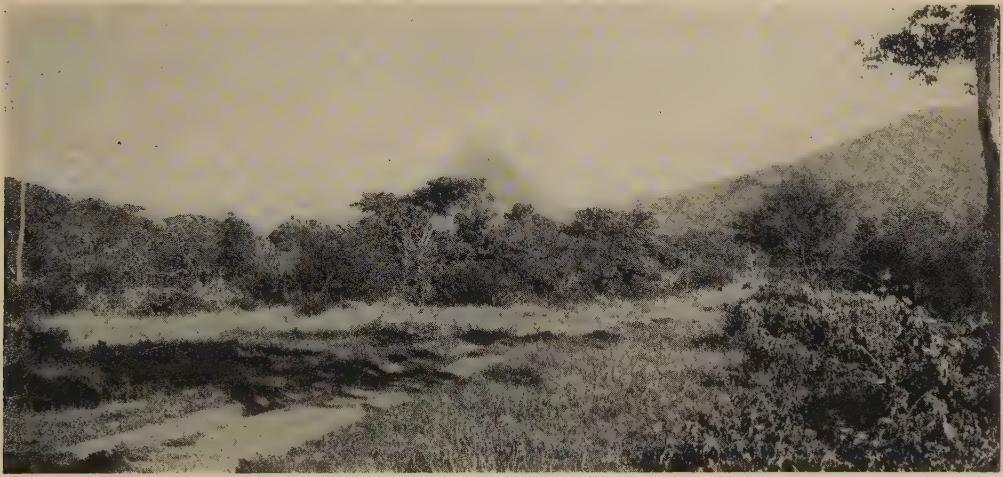

FIGURE 142.—Characteristic vegetation of the Llanos with open savannas, bush and gallery-forests alternating. On the road from Ortiz to El Sombrero (Guárico). In the background "galeras"—hill ranges in the Central Llanos. (Courtesy of Peter Christ.)

In the Colombian *llanos*, forest products attain some commercial importance and comprise chiefly sarsaparilla and a small amount of rubber. In these southern plains, the more evenly distributed rains cause greater tree growth and a better cover of grass, but remoteness deters progress.

CATTLE-GRAZING INDUSTRY

At one time regarded as among the most valuable of potential grazing lands, the *llanos* have fallen far short of producing a great cattle industry. Moreover, there exists no immediate prospect for an approach to even moderately important development.

In general, the *llanos* offer many attractions for cattle-grazing for they are vast plains covered with grasses. In addition, the region lies nearer to Europe than Argentina by a full week. With the increasing need for crop land throughout the world, new grazing lands must be utilized, so that some degree of advance in the region is certain, but natural and imposed handicaps abound.

During the flood season, rising waters force the cattle to the swells, from which they soon remove the available grasses. Many perish in the attempt to reach areas where the grasses have not been grazed. With the recession of the floods, immense swamps remain for some time, breeding places for pestilential germs spreading disease and death among men and beasts. Later in the year begin the ravages by the tick. In a few months after the floods, the land becomes drier and under the warm, moisture-gathering trade winds, the plains soon experience a serious shortage of water. The grasses grow hard, dry, unpalatable, and unnutritious. Then only irrigated pastures of alfalfa or *Pará* or *Guinea* grass can supply the needed fodder (Fig. 143).

Transportation routes and facilities interpose additional difficulties. To reach markets, cattle must be driven long distances. The major outlet is that through the low pass in the coastal range to Puerto Cabello. A domestic monopoly of pasture land, at this point where cattle require fattening after the long trip, has effectually prevented the natural growth of foreign investment. The outlet through the gap in the low coast range to Barcelona and to Guanta is less difficult, but as yet the scarcity of fenced pastures hinders its rise. Large numbers of live cattle also leave the region by way of the Orinoco River, via Ciudad Bolívar or Barrancas.

While in addition to the foregoing hindrances labor is scarce and unskilled, possibly the most powerful of the obstacles barring the way to the industry lies in political conditions. In Venezuela where the industry has attained greatest proportions, grazing has suffered greatly from the political vicissitudes in the country's history. Introduced from Andalusia by the *Conquistadores* in 1548, cattle were allowed to run wild; and in colonial times grazing held an importance far greater than that of the present. In eastern Colombia, the plains remained barren of cattle for several centuries. A class of semi-nomadic herdsmen appeared, the *llaneros*, under whose care the herds increased rapidly; by 1812, 4,500,000 head grazed the broad grasslands. The wars of independence decimated the ranks of *llaneros* as well as the herds and a notable decadence of the industry ensued; in 1823, approximately one-quarter million animals

FIGURE 143.—Llanos de Araure. The tall coarse grasses almost hide the two animals in the foreground. Gallery forests along streams. In the distance the southern ranges of the Northern Andes. (Courtesy of Ernest G. Holt)

remained. The surviving animals served as the nucleus for a period of growth interrupted, however, by a series of civil wars. In 1864 the *llanos* supported 6,000,000 cattle; 1873, 3,500,000; 1883, 8,600,000; 1901, 2,000,000; 1924, 3,000,000, generally of poor quality, and requiring a long period of improvement to fit them for active competition on world markets (Fig. 144.)

THE OUTLOOK

That the *llanos* face a near future brighter than their present condition is improbable. Foreign capitalists show a natural hesitancy towards investing the needed millions of dollars in an industry so liable to interruption by political influences. In recent years, the critical situation arising from the overemphasis of development in the Maracaibo oilfields has increased this disinclination to exploit the resources of the Llanos Grazing Region. Without capital, the handicaps of character of forage, and of flood, drought, pestilence, distance, and labor assure the prolonged unprogressiveness of the grazing industry in interior Venezuela and eastern Colombia.

THE GUIANAN LITTORAL

In the long narrow strip, extending from northwestern British Guiana to eastern French Guiana, lies one of the most productive agricultural regions of lowland tropical South America. Much of the wealth produced by the region may be ascribed to the favorability of certain natural conditions, but on the whole greater importance must be attached to the overcoming of certain unfavorable factors as the basis for Guianan wealth in sugar, coffee, cacao, rice, coconuts, and numerous minor products. In this connection, the Guianans, more notably the British and Dutch portions, owe much to their relations with the mother countries. Without the capital forthcoming from England, Holland, or France, the hot, humid, essentially swampy and unhealthful coastal strip composing the region would have remained simply a land to be avoided, a condition still holding in adjacent territory. As it is, however, the Guianan Littoral has experienced agricultural development over a period longer than for most parts of the continent.

The early interest of Europe in tropical lands, as potential sources of sugar primarily, gave the original impetus to agriculture in the region. On account of its adverse climate, the region had practically no indigenous labor supply. Hence the importation of labor began at an early date and from this immigration the bulk of the population and the chief features of agricultural production have arisen. For example, the East Indians, who now make up 42 per cent of the 300,000 people in British Guiana, not only furnish the labor for agriculture but they have installed rice as a leading commodity of domestic and foreign trade. With the Indians may be classed the second large population group, comprising the descendants of the African negro slaves who originally manned the sugar plantations.

In addition to its adaptability to sugar production, the Guianan Littoral profits by its proximity to Europe. Although this situation was a potent factor in the rise of the region, conditions of internal transportation, in contrast, have constituted a major hindrance. The narrowness of the agricultural belt

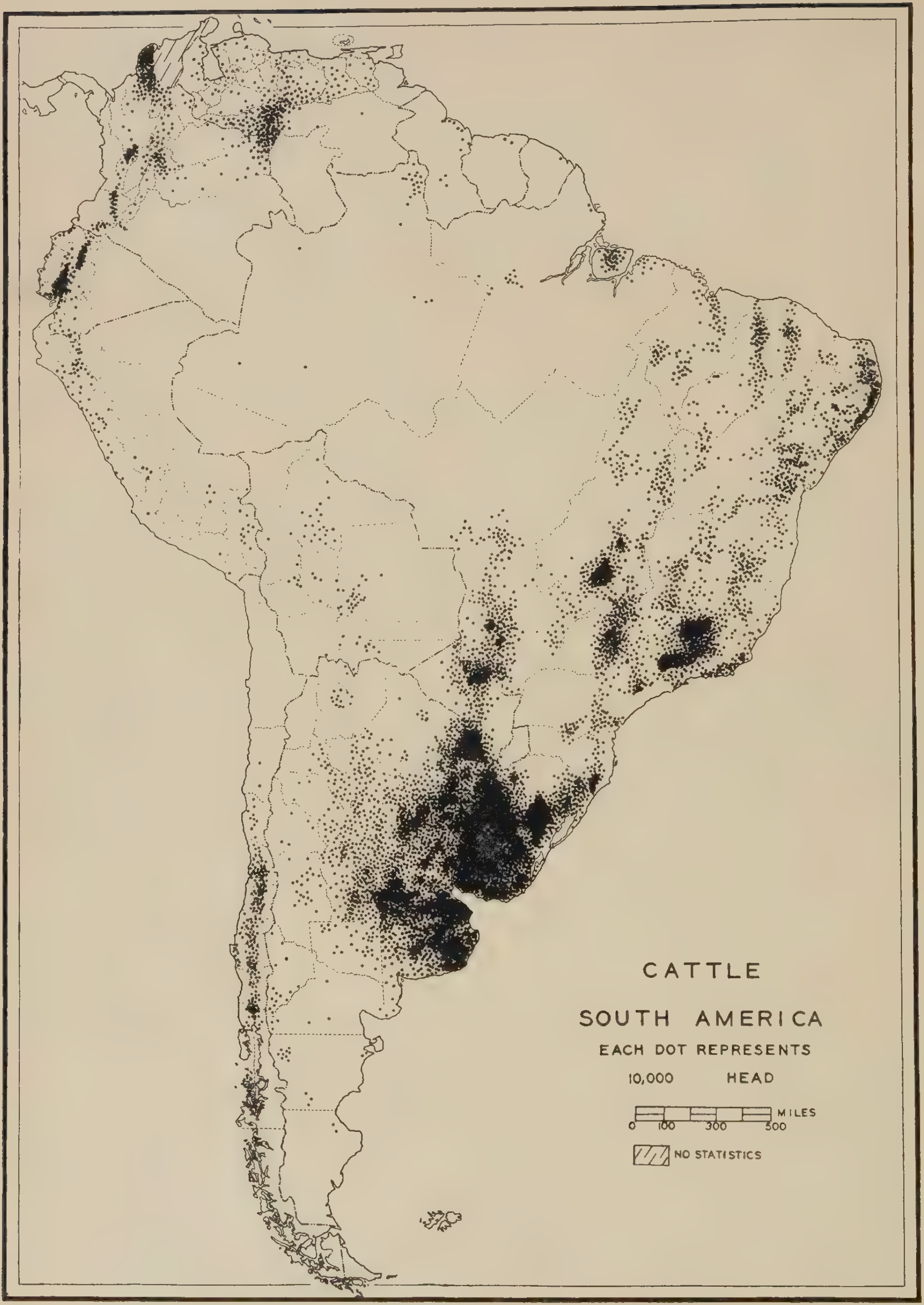
CATTLE
SOUTH AMERICA
EACH DOT REPRESENTS
10,000 HEAD
MILES
0 100 300 500
NO STATISTICS

FIGURE 144.—The distribution of cattle in South America. In the northern portion of the continent a number of cattle grazing regions stand out strikingly. They include, the Bolívar Savanna, the Cauca Valley, the Savanna de Bogotá, and the vast Llanos of Venezuela. (From "Commerce of South America," C. F. Jones. Courtesy of Ginn & Company.)

reflects the primitive condition of communication with the forested interior. Only along the low coastal plain, across which flow myriad streams, and in the lower valleys of the principal rivers, does agriculture find commercial development possible. These lands, in many sections protected from inundation by dike systems introduced by the Dutch, are in the heart of the region, the point of origin of all progressive tendencies, and the only portion of the three colonies likely to undergo much agricultural progress for many years.

SURFACE OF THE LAND

Most of the cultivated land consists of flat, wet, alluvial coastal plain, in a belt of savannas, which requires constant drainage of waters brought by rains, rivers, and the sea. The soil materials of unconsolidated sands, clays, and humus have great depth. When properly drained and freed from its impregnation of salt, the characteristic clay or clay-loam is exceptionally fertile. Rising slowly towards the interior, the alluvial stretch grades into a zone of sand hills.

Though the levelness of the surface and the fertility of the soils favor tillage, problems of flood waters are serious. In addition to the frequent undesired inundations of plantations, the powerful major streams may destroy extensive tracts of cultivated land. On the other hand, by reason of their huge loads of sediment, the same streams contribute to the arable land. Each large river has numerous islands near its mouth, where mangrove and other semi-aquatic forms rapidly transform sand-bars into potential farming land.

CLIMATE

As in most of tropical South America, its climate distinctly handicaps the Guianan Littoral in its ability to attract immigrants. For its leading agricultural products, in contrast, climatic features prove highly suitable. Most of the region receives an annual rainfall of more than 80 inches, with a dry season over all the region occurring about the time of the September equinox. At times, droughts become sufficiently intense to damage crops, but in general the doldrum rains guarantee ample rainfall for crops at all times. High humidity and high temperatures make the climate uncomfortable to white men, although for parts of the year the northeasterly and southeasterly trades somewhat alleviate the enervating effects of the heat. At Georgetown a difference of only 2.3° F. obtains between mean monthly temperatures of the warmest and coldest months, while at Paramaribo and Cayenne the contrast in seasons is even less.

AGRICULTURAL PRODUCTS

The expenses of maintaining agricultural land on a large scale and the ease of producing a few provisions for home consumption make for a close dependence of the leading crops on external markets. Rice, next to sugar, the principal crop, holds first place as a foodstuff for the masses, and also provides a considerable quantity for export. The laboring classes supplement their important dish of rice with the yam, cassava, sweet potato, plantain, several indigenous legumes, and various vegetables like tomatoes, egg plants, and okra. In addition to sugar and rice, the major crops grown for export embrace coconuts, coffee, cacao, and limes. British Guiana accounts for the bulk of agricultural production, Dutch Guiana for a substantial amount, and French Guiana for little except to maintain a domestic supply for its 44,000 inhabitants.

SUGAR CANE

Though sugar cane holds first rank among the crops as well as products in general of the Guianas, the industry has not prospered well for many years. Annual production averages 100,000 tons, of which British Guiana accounts for nine-tenths on some 50,000 acres of land in cane, an area representing more than 40 per cent of the total land in crops in the country. The industry has had a long history in the region, succeeding cotton which prior to United States competition prevailed among the crops. The multitude of difficulties besetting cane production, however, have caused a constant decline in the number of plantations, though increased efficiency in technique has been effected at the same time. In 1825 in British Guiana there were more than 200 sugar estates; today there are less than 40. Dutch Guiana has four estates, Cayenne none.

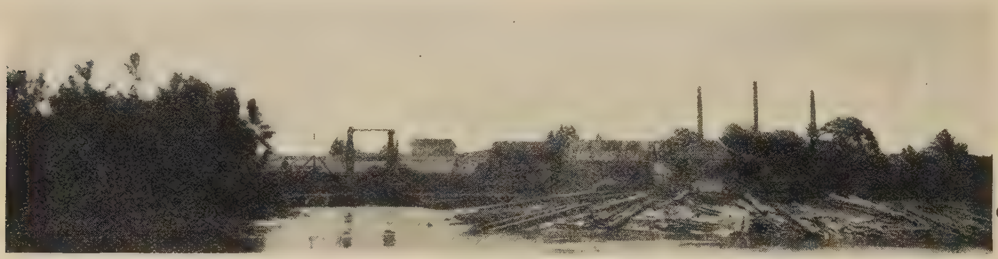

FIGURE 145.—Several factors favor cane production in the dyked lands of British Guiana. The three tall smoke stacks are those of a large *Central*. At the left the dyked gate is raised to let the water drain off of the low flat lands while the tide is out. At extreme low tide the gate is lowered to keep the water off the land.

Several factors favor cane production: ample precipitation, abundant fertile land, excellent means of transport between field and mill by numerous drainage canals, and preferential tariffs (Fig. 145).

In return, much of the land comprising the estates lies below the level of high tide. Consequently, behind the natural barrier of *courida* or mangrove, a dam of earth must be constructed to form a further barrier against the sea. Next to the front dam comes a small strip of grasslands used for pasturing a few horses and cattle, intersected by either a public road or railway, on either side of which extends a canal; these fields are criss-crossed by numerous trenches. In many cases the area occupied by dams and trenches amounts to 10 per cent of the total area of the plantations, which extend back lengthwise from the river or sea in rectangular blocks, and an additional dam guards against floods from the land.

The innumerable drains crossing the fields preclude the use of large machinery, a most unfortunate situation in a region suffering from a dearth of labor. Manual labor serves therefore for planting, cultivating, and harvesting. Furthermore, the industry has had to face declining prices and very effective competition.

As a result of efforts to meet competition, modern methods of manufacturing are the rule. The majority of estates have from 1,000 to 2,000 acres under cultivation; the largest, on the Demerara River, has 7,200 acres annually, producing 12,000 tons of sugar. Each estate produces its own sugar and sugar by-products. Of the latter, rum is of considerable importance. Commonly, the planters obtain one direct and one ratoon crop. Following ten or more years of planting, the soil generally becomes exhausted. To restore the productivity of the soil fertilizers are rarely used. Instead, fields are flooded for six to twelve months, the land then is drained, and cropping begun again.

RICE

In the early 1870's, British Guiana had a yearly import of more than 30,000,000 pounds of rice. Today, the grain has proved so well adapted to the physical conditions of the coastal savannas, that it not only supplies all regional needs of Indians in Demerara and of Javanese in Surinam, but holds an important place in the British Guianan export movement.

Large areas of land possess the requisites of rice production: heavy rainfall, warm climate, good irrigation facilities, and excellent soils. Labor is not so serious a problem as in the case of sugar, since the rice is cultivated chiefly by the small farmers, and the East Indian feels at home in the rice fields. Many of the small farmers rent portions of abandoned sugar estates, in order to plant their rice on the flat, heavy lands which in the long years of cane cultivation have developed an almost impervious subsoil, an important factor in the cultivation of rice.

First introduced early in the eighteenth century, rice soon came to be cultivated in many districts, although on a small scale. Its excellent keeping qualities and its high yields created a demand for the grain, especially as a food for slaves. Up to 1886 the area given over to rice production remained small and lay in separated districts of the Essequibo, Mahaica, Abary, and Canje Rivers. At present, the principal areas lie on Wakenaam Island and on the coast from the Supenaam River to Hampton Court. Acreage averages some 30 per cent of land in crops.

Although most of the grain comes from small farms, large scale operations have begun. These resemble the methods in use on the machine-cultivated rice lands in the United States, and effect a decidedly worthwhile economy of labor.

MINOR PRODUCTS

Coconuts play an important part in the agricultural economy of the Guianan Littoral. In British Guiana alone, the trees grow on more than 30,000 acres. They flourish and bear prodigiously on sandy coastal soils, although frequently hurricanes lay waste over large areas. Also, the diked coastal lands lack the proper movement of ground water to insure the most healthy growth of the trees. Most of the nuts come from small estates and supply domestic requirements for coconut oil and cattle feed, the former of which is consumed in great quantities by the East Indians.

At one time in the 1830's, Demerara exported 10,000,000 pounds of coffee per year. The berry was of excellent quality, but the destruction of a labor supply by the emancipation of slaves caused the decline resulting in a production barely sufficient for local demand. In Surinam cultivation of coffee is of far more significance at present than in the western colony, annual production totalling some five and one-half million pounds, and the crop ranking second to sugar. Liberian coffee predominates among varieties.

Additional crops include cacao of excellent quality which may be grown in many areas on the lower reaches of the rivers, where protection from winds may be had, and where proper drainage is provided. Production is restricted, because of lack of capital in British Guiana and the ravages of the witches-broom disease in all areas. Somewhat more than 1,000 acres of limes also engage the attention of producers in the Guianan Littoral and now produce more by value than cacao.

The raising of livestock claims little attention in the Guianan Littoral. Large areas of the coastal savannas can support cattle and a few animals do graze the grasses. Most of the cattle are highly mixed, a goodly percentage having *zebu* blood. Water supply raises the chief obstacle, for in the rainy season pastures are flooded, cattle often grazing more than knee-deep in the water; and in the dry season frequent shortage of palatable water occurs. Cattle shipped in from the *Llanos* compete in the markets of the coastal districts with cattle from the nearby savannas (Fig. 146).

THE FUTURE

The prospects for any widespread advance in the agriculture of the Guianan Littoral are limited. While the region possesses large areas of potentially arable land, both within its borders and available farther inland, the necessary urge to develop them will not come for a long time. The existing régime of an agricultural system based on sugar as a mainstay has supported the land for almost a century, but today even under the stimulus of notable tariff preferences the industry has a hard row to hoe. Crop diversification may increase the area of land in crops and thereby production, but the region has always to contend with the problems of its climate with regard to population. Furthermore, sugar, rice, coconuts, coffee, cacao, and limes are grown in a large nearby and highly competitive zone. Hence

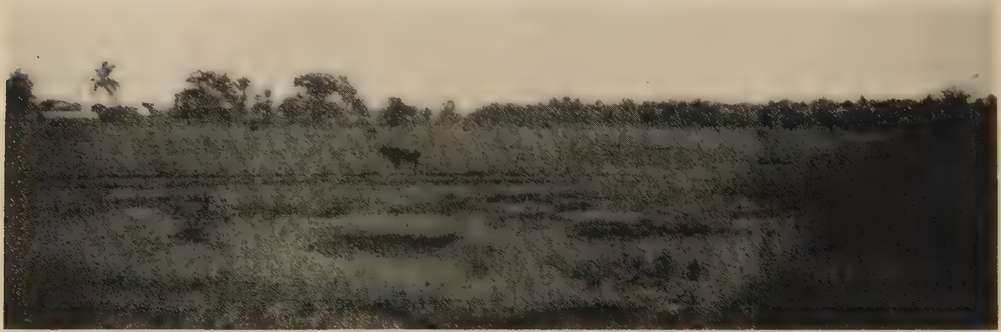

FIGURE 146.—The Coastal Savannas of British Guiana only a short distance back of the sea wall. These flat low lands, though providing fairly good pastures are of little use agriculturally unless well drained.

capital tends to refrain from development of these less favorable lands. The principal expansion of agriculture must come from the adjustment to natural increase in population, as well as possible changes dependent upon mineral exploitation, and from the growth in numbers of the small farmer.

THE GUIANAN FOREST AND GRAZING REGION

Notwithstanding an area greater than that of Chile, the Guianan Forest and Grazing Region has a total population among the smallest of the agricultural regions of South America. Considerably more than 200,000 square miles of its territory has a density of population of less than one-fourth person per square mile. Little is known of the region except about its margins, interest in its resources does not develop much importance, and the great handicaps inherent in an isolated, largely heavily forested tropical region guarantee the maintenance of this situation.

Human activities that have arisen could do so only by overcoming or modifying the effects of a practically non-existent system of communication. Forest industries operate where access to a stream may be had; grazing has arisen in the interior solely because cattle furnish their own transportation when, and if, necessary; and tillage of the soil occurs in tiny patches along stream courses or near the several mining enterprises. The exploitation of minerals, in particular, has served to establish certain of the agricultural industries, in that the search for gold or diamonds leads men on into the districts commonly regarded, from an economic standpoint, as practically unattainable at present.

To the native Indian somewhere in the vast protecting forests, the outside world represents an unknown quantity. The forests provide food, shelter, and opportunity for crop culture sufficient for his limited needs. Only about the margins, where collecting and distributing points have grown, do relatively large centers arise. Such are the Orinoco part of Ciudad Bolívar, which serves most of the Llanos and practically all of Venezuelan Guiana, and has a population of 20,000; Georgetown, also a strategic commercial, as well as administrative, center, having access to the sea and to two principal rivers in British Guiana, with a population of 55,000; Paramaribo, on the Surinam River, and Cayenne on the Cayenne River, each bearing the same relationship to its country as Georgetown, and having populations of 40,000 and 15,000 respectively.

Physical Setting

Though with regard to degree of development, the region exhibits a uniform aspect, the various natural elements show considerable diversity. The implications of the two distinct occupations—forestal and pastoral—suggest a basic set of major differences.

Rising from sea-level, at the delta of the Orinoco River, to an altitude of 8,600 feet in the giant table-mountain of Roraima, at the Venezuela-Brazil-British Guiana boundary, the region has considerable variation in land features. In general, however, that portion south of the Orinoco may be designated a plateau of moderate relief, though deeply seamed in many places by many torrents. The highest lands are tabular, frequently barren, sandstone areas, about which lie extensive crystalline surfaces of irregular relief, here and there capped by volcanics. To west, north, and east, the region grades into the alluvia of Rio Branco, Orinoco, and coastal plain districts respectively. The sandstone districts have occasioned much of the savanna land in the region, while the soils weathered from the granites, gneisses, and diabase support a usually dense stand of forest (Fig. 147).

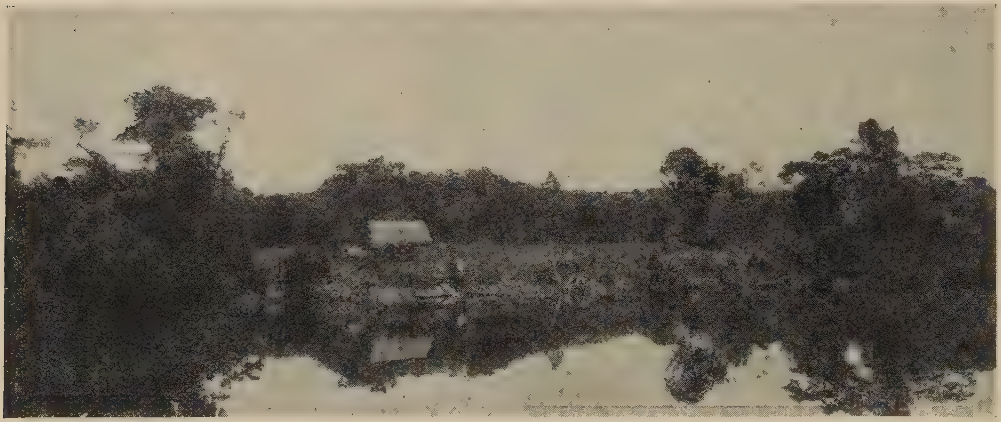

FIGURE 147.—A small clearing in the greenheart forest region along the Demerara River. In these forest clearings a little primitive agriculture is practised by the native population. The soils being sandy or sandy loams leach very rapidly under the method of cultivation.

Most of the region is hot and humid, with an annual rainfall of between 40 and more than 80 inches, the totals for the Guiana colonies, in general, far exceeding those for Venezuelan Guiana. Near the east-west portion of the Orinoco and about the headwaters of the Rio Branco, flowing to the Rio Negro and the Amazon, and about those of the Rupununi River, flowing into the Essequibo, a broad divergence in seasonal totals accounts in part for the savannas of those areas. Owing largely to their elevation, the savannas also are cooler and more healthful than the contiguous lands.

By far the larger part of the region lies clothed in a heavy forest of significant value. The sands and clays of the peripheral lands in the Guianas, the gray alluvia of the Orinoco delta, and the Southeast in the Venezuelan territory of Amazonas support the most luxuriant growths. In most respects—profusion of species of trees, epiphytes, leaves and undergrowth, and economic utility—they resemble the Amazonian forest. The principal forest industries, however, here depend upon resources different from those employed in the region to the south, but the difficulties of exploitation remain essentially the same. The savannas cover extensive tracts, but lack of population and transportation facilities prevent important development.

FOREST INDUSTRIES

In its proximity to the sea the Guiana Forest and Grazing Region enjoys a great advantage over the Region of Amazonian Forest and Primitive Agriculture. Many of the streams which flow through the forests are navigable to the sea, though for only short distances. Hence, timbers provide for a major industry, but here, too, a form of rubber—*balata*—claims greatest attention.

Balata (from *Mimusops globosa*) is the principal forest product of Venezuela and of the three Guianas. The tree occurs in scattered solitary specimens or groves throughout most of the forested area, but the principal producing districts are those of Tumeremo, in Venezuela, to the southeast of Ciudad Bolívar, and in the Amazona territory. The crudity of methods used in tapping has wiped out the industry in many areas but a realization of the value of this resource has prompted the enactment of strict regulative measures over all of the region, enforcement of which necessarily leaves much to be desired.

Timbers provide the second forest industry of importance, and include a large number of useful species. The Guianan portions carry on most of the activity, owing to the accessibility of the forests and the proximity to a large local market as well as to facilities for shipment abroad. Though much of the forested area lies in inaccessible places, the utility of the Guianan stand ranks it among the most valuable of South American sources of timber. Of the trees, the greenheart (*Nectandra rodioei*) has the greatest value and is exported only by British Guiana. Its exceedingly durable wood is much sought for use in constructions. Owing to the great specific gravity, the logs are braced on the outside of large punts by means of the abundant creepers and floated to market. The mora (*Dimorphandra mora*), also having extremely hard resistant wood, of considerable economic importance, is a second form of great value. Softer woods including crabwood (*Carapa guianensis*) and wallaba (*Eperus sp.*) have a greater stand than the hardwoods and supply far more lumber. The wallaba, most abundant of timbers in the commercially developed forests of the east, composes 40 per cent of the total forest wherever it grows. The western forests, because of their remoteness, yield little timber, only a few logs of cedar (*Cedrela odorata*) going downstream for export from Ciudad Bolívar to Trinidad (Fig. 148).

The tonka bean, the extract of which is an important perfume base, leaves the region in large quantities, chiefly via Ciudad Bolívar. The tree (*Dipteryx odorata*) grows especially well in the north, in the valleys of the Coura and Cuchivero Rivers, near the Orinoco.

The forest exercises a profound influence over the life of the native. Not only does it provide labor through the year—gathering of balata and rubber comes in the wet season, of tonka beans in the dry season—but it also affords food, clothing, and shelter. On the delta of the Orinoco the close dependence on the forest is noteworthy. Here a single tree, the *morihe* palm (*Mauritia flexusca*), furnishes most of the living requirements for entire tribes—trunks and leaves for buildings, fibers for weaving, shoots, fruit, sap, and pulp for food. In other districts, clearings in the forest produce greater variety in diet, chiefly with the raising of *yuccas*, cassava, sugar cane, plantains, bananas, and some corn.

GRAZING

Though the region embraces extensive areas of savanna, grazing progresses slowly because of the lack of transportation facilities. The

The nature of the region militates against rapid exploitation. Hundreds of thousands of square miles lie virtually barren of even primitive Indian settlement, not only because of the unhealthful climate, but also as a result of the great distances to sources of supply and the difficulty of traversing these forested and commonly swampy distances. Such products as do emerge here reach markets chiefly because of their ability to overcome the handicaps of difficult transport, either as a result of high unit value or cheapness of exploitation. Thus do rubber, Brazil nuts, cacao, timber, and many minor forest products enter trade channels. Potential food crops and livestock have little importance other than a local one. In no case is the high unit value or cheapness of exploitation attributable directly to development by man. Here there has occurred no change comparable to the improvement of cattle grazing in Argentina or to the growth of the yerba maté industry in the Subtropical and Yerba Maté Forest.

Were the magnificent system of navigable waters afforded by the Amazon and its tributaries, the region would [illegible] be lost to exploitation. On the other hand, because of these great fluvial highways, Manáos, at a distance of more than 1,000 miles from the sea has 75,000 people and is the entrepôt for possibly one million square miles, while at the mouth of the great system, Pará has a population of more than 225,000. The high percentage of illiterates among people employed in these primitive pursuits indicates the low stage of agricultural development of the region. Railroads have little influence on the collection or transportation of trade imports and exports. The region has only a few hundred miles of expensive line, the longest of which, that paralleling the rapids of the Madeira and Mamoré Rivers for 226 miles, finds operating costs too great to permit much growth in traffic.

Physical Conditions

Despite the size of the region, a most notable feature is the uniformity of physical conditions. In general, this is a great basin of comparatively little relief, forested almost entirely, and under the influence of a tropical humid climate. Though it embraces 1,700 miles in extent from north to south and 2,400 miles from west to east, practically all of the region has an elevation of less than 1,000 feet and easily one-half of this area lies under 500 feet. Were this region to have a climate like that of the Central Plains of North America, its lack of great relief would make it one of the great producing areas of the world; but a true tropical climate, with its concomitants of rain forest and tropical soils, gives the Region of Amazonia Forest and Primitive Agriculture its predominantly backward aspect.

Climate

This region is the world's largest continuous territory having that climate most commonly associated with equatorial latitudes. Temperatures average high throughout the year and daily range exceeds seasonal range, so that night constitutes the winter of the tropics. At Manáos November has the highest mean monthly temperature with 83° F., March, the lowest, with 78° F. The monotonous continuity of the great warmth, coupled with the high relative humidity, is especially detrimental to human initiative. The native in the

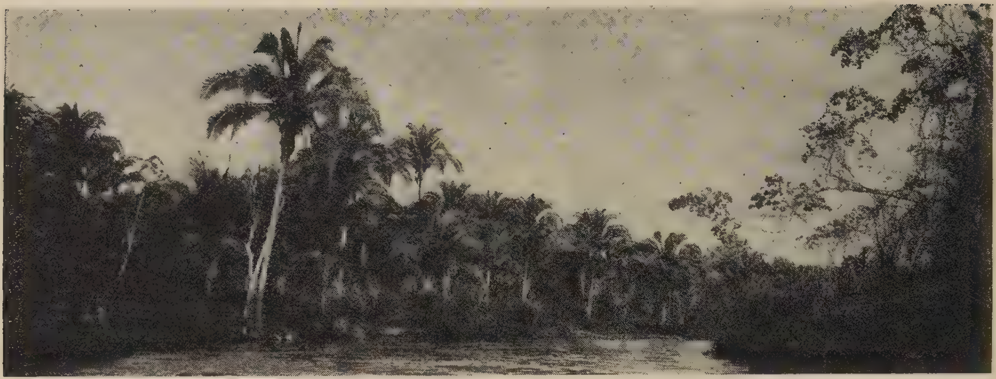

FIGURE 149.—Palm forest on Rio Itapicurú, near Caxias Maranhao; on the border zone between the Campos grazing region and the Amazonian forest. (Courtesy of Ernest G. Holt.)

original state can easily produce a sufficient store of foodstuffs with the result that apathetic indolence is a normal characteristic. Little need exists for the production of large quantities of supplies as a protection against possible famine in a poor season.

The rains have an important part in distinguishing the region from neighboring areas. Almost all of the land receives more than 60 inches per year falling generally in heavy downpours, the distribution of which accounts for the principal differences in climate and utilization of land among various sections of the region. The far west is conspicuously the wettest portion with annual totals approaching 125 inches. Practically every week brings drenching rains, though about the time of the June solstice a less rainy season holds sway. East of the Rio Negro-Amazon confluence rains decrease considerably and the drier season from June to November brings sufficiently dry conditions to favor relatively large tracts of savanna.

VEGETATION

For present-day purposes, the vegetation of the region provides its most valuable natural resource and has done so since earliest days of exploitation by white men. At the same time, the great tropical rain forests are the major obstacle in the path of progressive development for the region, because of the difficulty of travel (Fig. 149).

Covering almost all of the region, the forest mantle contains an astonishing number of species. With the more valuable of these, the economic history of the Amazon Valley has been closely identified. Even granted adequate means of transportation exploitation proves difficult, owing to the scattered occurrence of the trees, the tangles of creepers and underbrush, and in the case of timbers a specific gravity in many cases greater than that of water. Nevertheless, profits are great enough to promise the continued dominance of forest industries in this region for many decades.

Aside from the distinction between the savannas of the north and that in eastern Marajó Island and the forest formation, the major groups of plants are divided on the basis of height above the rivers. The mangrove thickets about the mouths of the Amazon are especially well-de-

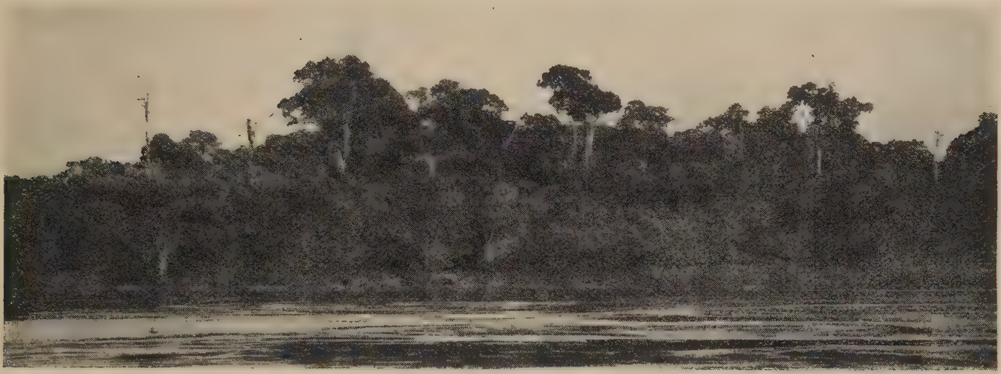

Figure 150.—Tall Brazil nut trees rising above the rather dense undergrowth on the Rio Tacontines near the southern border of the Amazon Region. (Courtesy of Ernest G. Holt.)

veloped, giving way to a tidal lowland forest a short distance inland. Upstream, the alluvial plain or *varzea* in places had large trails of grassland, but westward particularly it supports a dense growth of medium height. Here grow two of the most valuable trees of the region, the *seringueira* (*Hevea brasiliensis*) the principal source of rubber, and the cacao (*Theobroma cacao*). Above the flood zone, the forest attains its greatest variety and includes the important Brazil-nut tree (*Bertholletia excelsa*) and the *caucho* (*Castilloa elastica*). Here, also, originate the harder timbers (Fig. 150).

RELIEF AND SOILS

The vast lowlands composing the bulk of the region consist of three types of terrane, all of gentle relief and in that respect eminently suitable to the mechanical requirements of machine agriculture. Comprising approximately one-tenth of the total area, the alluvial districts, generally swampy, include comparatively narrow strips along the rivers. Though most of these lands have heavy dark soils of poor drainage, in some districts well-drained loams of high productivity border at the river banks. The latter are the principal crop-producing soils of the region. The upland plains of two types—lower, near the rivers, and upper, over the rest of the region—are fairly well-dissected and well-drained areas. Soils average moderately heavy, but have a strikingly friable structure. Their productivity is high, but short-lived without the aid of artificial fertilizers.

PRODUCTS

For the region as a whole the cultivation of crops and the grazing of livestock are subsidiary to the forest industries. Concentrations of tilled lands or of livestock owe their origin primarily to the needs of laborers in the forests. About Pará, at the mouth of the Amazon, has grown the leading agricultural district, from which products go to all parts of the region. Other important producing areas lie about Obidos, Manáos, Iquitos, and in the Acre territory.

RUBBER

For many years, rubber constituted the sole barometer of economic activity in the region. The bonanza of "black gold" stimulated the land to feverish exploitation of its great resources in the valuable latex. For more than thirty years rubber created millionaires in Brazil. Collecting of the latex began in the 1870's on the islands at the mouth of the Amazon and in the 1880's in the more important Acre district. Labor for the former came from Pará, while a series of drought years sent thousands of people from Ceará to the western rubber lands. With the unwise imposition of heavy export duties, the producing states gave foreign competition by plantation rubber, a great opportunity and paved the way for the crisis which has led to the present low status of the Amazonian industry.

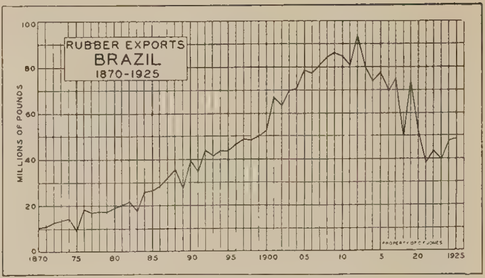

FIGURE 151.—Brazil supplied the world with rubber until the opening of the twentieth century. Increasing shipments of plantation rubber from the Middle East after 1900 and the heavy export tax on wild rubber from Brazil (amounting to as much as one-third its market value in some years) brought on the crisis in the industry from which it has never recovered and probably never will.

The *seringueira* (*Hevea brasiliensis*), by far the principal rubber-producing species of Brazil, growing chiefly in the zone of the Purús, Juruá, and Acre rivers, as well as about the mouths of the Amazon, has served as the basis for the Brazilian rubber industry. The tree's usual habitat is the lowlands, humid or recurrently inundated. Hence, tapping occurs in the drier season and is accomplished by making incisions in the trunk. The rubber obtained excels all others in quality and is the "Para" or "fine" rubber of commerce (Fig. 151).

Caucho, derived from *Castilloa elastica*, is inferior to *Hevea* rubber and comes from the dry uplands. The tree grows in the upper basin of the Yavary, Juruá, and Purús Rivers and also on the higher lands to the north and south of the lower Amazon. Methods of exploitation are ruthless, consisting of cutting down the trees, and have resulted in virtual extermination of the species in Bolivia and Peru.

Though the rubber industry showed signs of recovery following the recent restriction on imports of British rubber by the United States, any large-scale development based on methods now in vogue in the region is impossible. The huge success of plantation rubber points to this type of production as the logical procedure. Though the Amazon lands, as the original home of *Hevea*, provide many favoring natural conditions, to attain a great plantation industry many handicaps must be overcome. These include: scant and inefficient labor, lack of governmental integrity and in consequence lack of capital, transportation costs, and the momentum already acquired by Far East plantations.

BRAZIL NUTS

In the diversification of occupations following the collapse of rubber, gathering of the Brazil nut has received greatest attention, so that this industry has become second to rubber among forest activities in the region. Production centers about Manáos and Pará, where the tree, the *castanheiro*, flourishes on the well-drained uplands. The industry has considerable promise, though as yet markets are small. Since only the fruit of the tree is used, collecting of the fallen capsules containing fifteen to thirty nuts does not direct harm to this resource. Moreover, the tree is widely and abundantly dispersed. The nut has high food value and the natives consume it in quantities.

MINOR FOREST INDUSTRIES

Despite the enormous extent of forests, the lumber industry has reached only small proportions and in all probability never will become an important branch of activity in the region. As in all tropical regions, most of the timber is extremely hard, has high specific gravity (rafts of light woods are required to float many timbers), and lacks pure stands. In addition, the forests lie remote from centers of population and efficient means of transportation.

Certain woods already have acquired a market, but growth continues slowly. Cabinet woods of quality include a number of varieties, but a soft-wood—known as the "cedar"—is cut in greatest volume as a result of its occurrence near the rivers. Since the "cedar" has both Paraná pine and United States yellow pine with which to compete, its markets are limited.

The diversity of plant life has led to a number of small-scale commercial industries, which have far less importance than lumbering. These include principally the gathering of *balata* and of many kinds of oil-producing seeds.

CULTIVATED CROPS

The wealth of forest foodstuffs and the effect of comparatively high wages to be gained by gathering rubber have prevented much agricultural development. Practically all production goes to local markets or is part of a subsistence agriculture. Sugar cane, cacao, cassava, corn, rice, and various fruits supply the bulk of necessities; of these corn occupies the largest acreage. Extremely crude methods prevail. For nearly all crops, the district about the large market at Pará has the greatest acreage. The potentialities for expansion in the production of sugar, cacao, and cotton are great and the continued diversification of industries will cause considerable though slow growth. Amazon cacao at one time supplied all of the world's trade in that commodity, only to decline with the rise of rubber and with the onset of numerous difficulties involving disease, floods, poor methods, taxes, and extra-regional competition. Today the chief centers of production lie between Manáos and Obidos and about the mouth of the Tocantíns, and occupy parts of the alluvial plains.

LIVESTOCK

The grazing of cattle has considerable significance on the island of Marajá where more than one-half a million head live on the frequently flooded pastures. Minor grazing lands lie in the savannas to the north of the estuary, and in several alluvial plain grasslands. Though the grasses are neither particularly palatable nor nutritious, beef of fair quality is produced for markets solely within the region; encumbered with tropical diseases, insect pests, and low-grade animals, the cattle industry of these far-away savannas can experience little development until more temperate pastures of the continent have been utilized.

THE OUTLOOK

Although thousands of square miles in this region remain unexplored, enough is known of the areas as a whole to indicate no great progress in the near future. A debilitating climate, hostile to white settlement; pestilence; great distances traversed only with utmost difficulty; scant peopling; agricultural possibilities limited as yet to products more easily obtained in other parts of the world; these factors will maintain the comparative insignificance of the vast plains of eastern Colombia, Ecuador, Peru, and Bolivia, and the great interior of Brazil. To attain great world importance the region has far to go. The mishandling of its valuable resources has set the land back many years. Only highly improbable efforts of titanic proportions can restore rubber to its former rank in world commerce. Cacao, also, has a long uphill struggle ahead. Diversification now under way in many parts promises much, but all evidence points to a long continuance of Amazonia's status as the largest and one of the least productive agricultural regions of South America and of the world.

THE POTATO INDUSTRY IN NEBRASKA

Esther S. Anderson

Geographer, University of Nebraska

DURING the last decade potatoes have ranked fourth in value of all crops in Nebraska, being surpassed only by corn, wheat, and tame hay. When a crop reaches the importance in the agricultural scheme of a state that the potato now holds in Nebraska, it merits serious attention. This article summarizes the results of a series of investigations made to determine what factors, environmental and economic, have been instrumental in promoting the development of the potato industry of the state.

REGIONS OF PRODUCTION

Although potatoes are grown throughout the state, Nebraska has three leading regions of production; namely, the western, central, and north central (Fig. 1). The western region is the heaviest producing area of both certified seed and table stock. An average of 46 per cent of the total crop in the state was grown in this region during the past nine years. The central region, located in the Platte Valley in Buffalo County and vicinity, is the chief source of potatoes for the markets in eastern Nebraska in late July, August, and September. The north central region, chiefly Brown County, supplies potatoes in the period intervening between those of the early crop of the central region and the ones of the late season in western Nebraska.

ENVIRONMENTAL FACTORS AFFECTING POTATO PRODUCTION

It is generally recognized that climate and soil are the principal natural factors in potato production. The yield is heaviest where the average temperature is 64° to 70° F. during the growing season and where there are practically no hot days. This temperature range is prevalent in June, July, August, and September (the growing season) in the western region of Nebraska, thus satisfying the thermal optimum (Fig. 2). July and August temperatures in the central and eastern parts of the state are usually higher because the altitude is lower than that of the western part. However, potatoes are successfully produced in these areas because they are planted earlier in the season when the temperature is lower and hence they are ready for the market before the advent of the high temperatures of July and August.

Although the annual precipitation increases from only 15 inches in the western part of the state to 32 inches in the eastern part, the summer rainfall is generally ample in all areas for potatoes because they grow quite successfully in areas having 8 inches of moisture during the growing season. Inasmuch as normally all parts of the state receive more than 8 inches during this season, the moisture conditions are adequate for good crops.

RESPONSE OF POTATO PRODUCTION TO CLIMATIC CONDITIONS

The climatic conditions of western Nebraska are comparable with those of the more northern potato-producing states—Minnesota, Wisconsin, and Michigan—insofar as the length

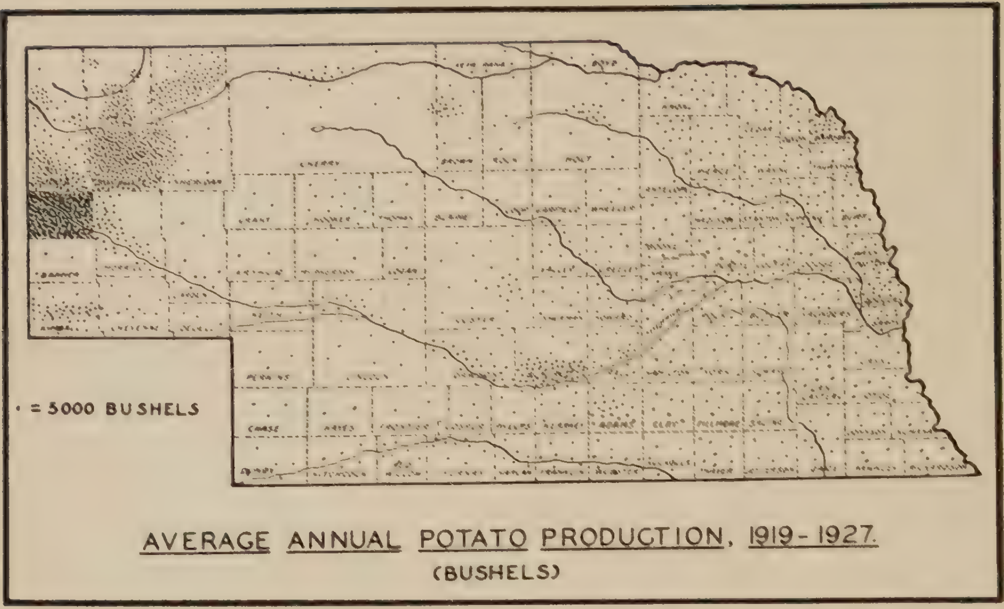
• = 5000 BUSHELS
AVERAGE ANNUAL POTATO PRODUCTION, 1919-1927.
(BUSHELS)

FIGURE 1.—An average annual production of 7,903,000 bushels of potatoes in Nebraska were produced from 96,000 acres, during the period 1917–1927. The western region of Nebraska is the principal producing area of both certified seed potatoes and table stock while central and eastern Nebraska are sources of domestic supplies. (Based upon statistics by Nebraska State Board of Agriculture, Lincoln.)

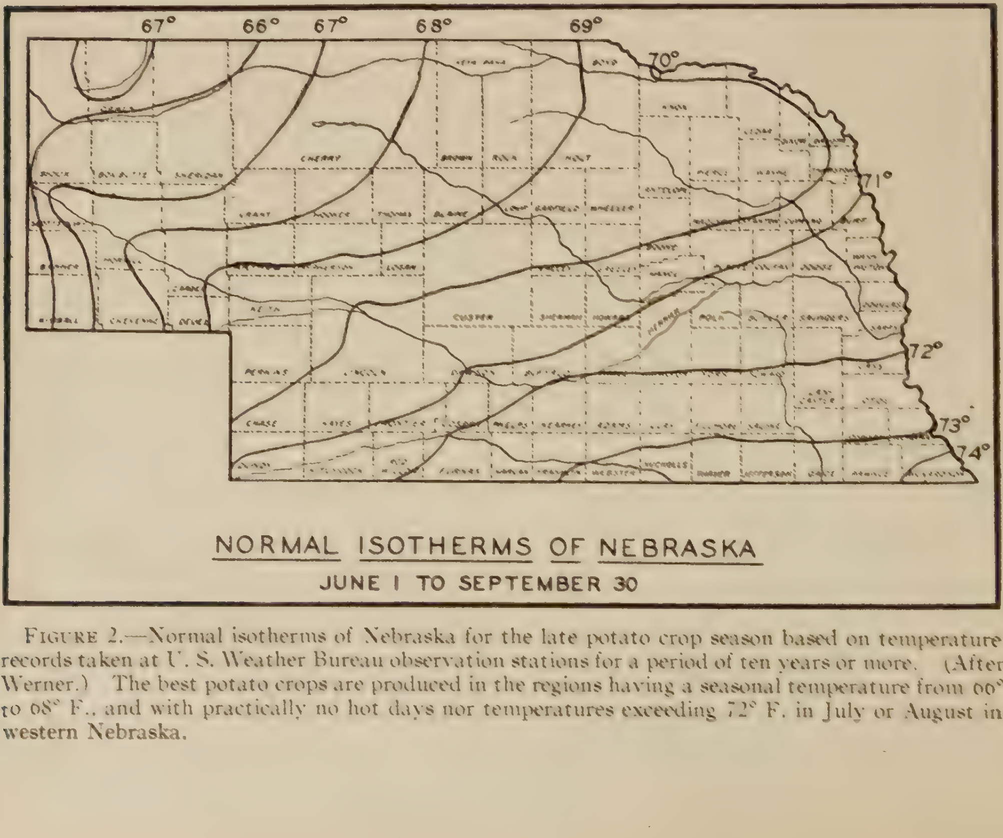
67°
66°
67°
68°
69°
70°
71°
72°
73°
74°
NORMAL ISOTHERMS OF NEBRASKA
JUNE 1 TO SEPTEMBER 30

FIGURE 2.—Normal isotherms of Nebraska for the late potato crop season based on temperature records taken at U. S. Weather Bureau observation stations for a period of ten years or more. (After Werner.) The best potato crops are produced in the regions having a seasonal temperature from 66° to 68° F., and with practically no hot days nor temperatures exceeding 72° F. in July or August in western Nebraska.

of the growing season and its mean temperature are concerned.

WESTERN REGION

Although western Nebraska lies in a lower latitude than these states do, a growing season with a mean temperature of 66° to 68° F. exists because of the high altitude, 3,500 to 5,000 feet, which is important in causing a lower temperature (Fig. 2).

The western potato-producing region may be divided into (1) the northwestern district which lies north of the North Platte River to South Dakota, and (2) the western district which includes the North Platte and Lodge Pole valleys and the table lands of the state south to the Colorado line (Fig. 3).

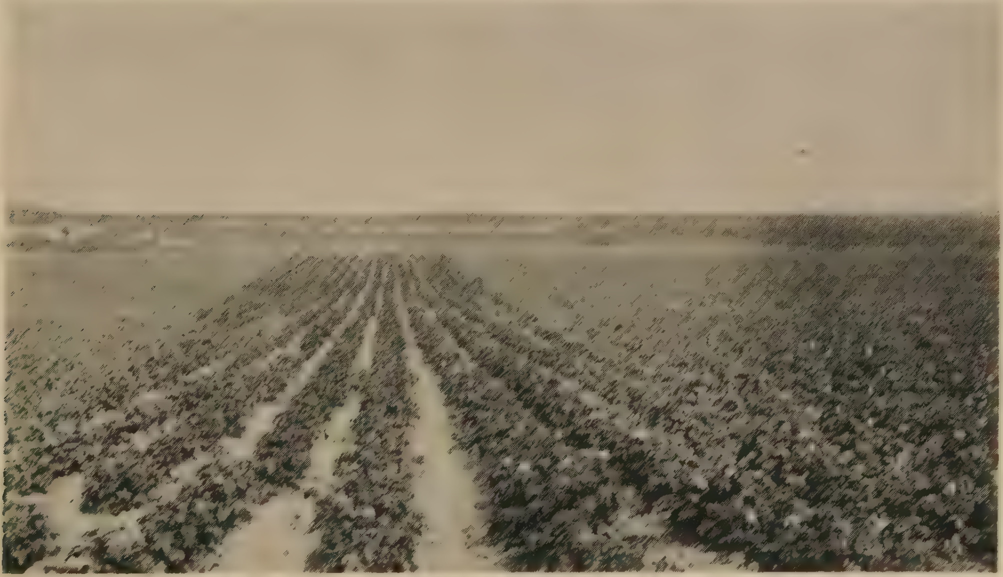

FIGURE 3.—A field of potatoes at the period of blooming near Marsland, Dawes County, Nebraska. This is a typical summer scene in the dry land certified potato producing region. The fields vary from approximately one hundred to many hundreds of acres. (Courtesy of Conservation and Survey Dept., University of Nebraska.)

Northwestern District

In the northwestern district four of the leading potato-yielding counties—Box Butte, Sioux, Dawes, and Sheridan—are north of the summer isotherm of 67° F.

The average yield per acre in the dry land section of this district shows a close relation to the temperature and rainfall during the years 1917–1927 (Fig. 4 and Table 1).

The correlation of the mean summer temperature and the production per acre show that the yields have been highest during the years in which the optimum temperature of 65° to 67° F. prevailed and when the July temperature was not higher than 72° F., 1917 excepted. In that year the July temperature was 74.35° F., but the rainfall was low causing a retardation of plant growth. This was followed by a cool August and September together with a heavier rainfall, which were favorable conditions for a rapid growth and maturity of the crop.

The importance of rainfall during the period, 1917–1927, is indicated

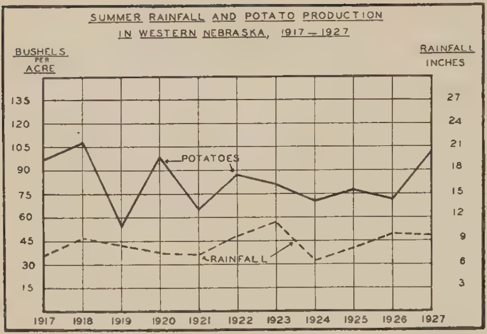

FIGURE 4.—The fluctuations in the average yield per acre in the dry land section of the northwestern district show a fairly close relation to the summer rainfall during the years 1917–1927. (Based upon U. S. Weather Bureau reports, and statistics by Nebraska State Board of Agriculture, Lincoln.)

by the fluctuations in the yields per acre which correspond closely to the variations in seasonal rainfall, except in 1921 and 1927. The decreased yield in 1921 was caused by a warm July and August and a relatively high precipitation, which were favorable conditions for a large amount of the disease, *fusarium wilt* or "stem-end rot."

TABLE 1

AVERAGE TEMPERATURE AND RAINFALL, JUNE TO SEPTEMBER, AND THE AVERAGE YIELD PER ACRE IN THE NORTHWESTERN CLIMATIC DISTRICT OF NEBRASKA, 1917–1927

						Temperature (Fahrenheit) *					
Month	*1917*	*1918*	*1919*	*1920*	*1921*	*1922*	*1923*	*1924*	*1925*	*1926*	*1927*
June	63.31	70.01	68.36	64.27	70.03	68.02	65.9	63.45	65.39	64.88	63.06
July	74.35	71.58	75.3	72.05	73.65	69.22	74.19	69.72	72.24	72.73	70.22
August	67.38	70.01	72.09	68.35	70.21	74.12	67.58	70.82	70.91	70.97	66.52
September	61.84	56.68	65.16	61.59	61.17	65.11	61.16	58.58	63.15	57.39	60.71
Average	66.72	67.07	70.23	66.71	68.76	69.12	67.21	65.64	67.92	66.49	65.12
						Rainfall (Inches) *					
June	2.10	1.5	2.22	3.13	2.56	3.15	4.24	5.32	5.36	2.5	3.82
July	.98	3.0	2.67	1.71	3.49	4.56	3.56	2.31	3.11	2.58	2.09
August	1.02	2.22	.86	2.25	2.26	1.64	4.25	1.85	2.51	3.52	2.18
September	1.84	2.22	1.67	.96	1.72	.82	2.34	1.50	1.16	1.34	1.01
Total	5.94	8.94	7.42	8.05	10.03	10.17	14.39	10.98	12.14	9.94	9.10
Annual	15.93	19.17	18.85	26.11	19.71	22.53	25.50	20.05	20.43	18.09	23.17
						Yield per Acre (Bushels) †					
County											
Cherry	90	117	45	85	71	77	79	52	77	75	92
Sheridan	125	120	40	91	86	81	73	47	105	92	106
Dawes	96	119	51	94	86	76	79	56	106	89	109
Sioux	118	103	120	147	145	112	110	105	140	153	149
Box Butte	85	111	48	91	80	50	80	46	95	90	107
Average	102	114	61	102	94	79	84	61	105	100	113
Average‡ without Sioux Co.	99	117	46	90	81	71	78	50	96	86	104

* Data compiled from reports of the United States Weather Bureau and coöperative stations at eleven places.

† "Nebraska Agricultural Statistics," Nebraska State Board of Agriculture at Lincoln, Nebraska and the United States Department of Agriculture.

‡ Much of the potato crop in Sioux County is produced under irrigation.

Although the summer rainfall was less in 1927 than in 1926, the yield per acre was 104 bushels, or the second highest during the decade. This was the result of a uniform mean summer temperature of 65.12°, the lowest during the period, and an evenly distributed seasonal rainfall of 9 inches. The highest yield per acre was 114 bushels in 1918 when the mean summer temperature was 67.07° F. and the rainfall exceeded 2 inches during each of the summer months.

Four of the five years having low yields per acre, had July or August temperatures above 73° F. In the past eleven years the highest summer temperature, the maximum July temperature, the minimum yield per acre and the second lowest seasonal rainfall occurred in 1919. The July and August temperatures averaged 74° F. and the seasonal rainfall was 7.42 inches. August, a critical month in the maturity of

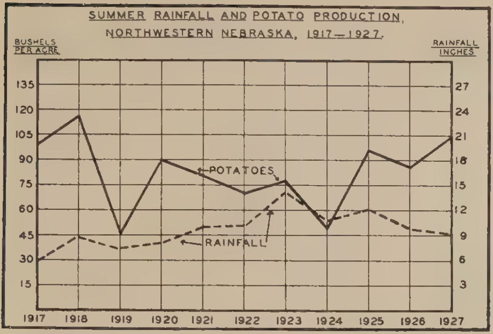

FIGURE 5.—The yearly variations in the production of potatoes per acre in the non-irrigated counties of the western district correspond quite generally to the summer rainfall but not as clearly as do those in the northwestern district. (Based upon U. S. Weather Bureau reports, and statistics by Nebraska State Board of Agriculture, Lincoln.)

potatoes, had only .86 inches of moisture. These unusually high temperatures and the lower rainfall, especially in August, caused the yield per acre to decrease to 46 bushels.

TABLE 2

AVERAGE TEMPERATURE AND TOTAL RAINFALL, JUNE TO SEPTEMBER, AND THE AVERAGE YIELD PER ACRE IN THE WESTERN CLIMATIC DISTRICT OF NEBRASKA, 1917–1927

Month	*1917*	*1918*	*1919*	*1920*	*1921*	*1922*	*1923*	*1924*	*1925*	*1926*	*1927*
Temperature (Fahrenheit) *											
June	64.49	72.58	68.14	66.49	70.05	70.40	66.92	66.54	67.82	66.23	64.31
July	74.04	72.49	76.11	72.95	75.27	71.52	74.94	71.34	73.76	72.44	71.16
August	67.86	71.22	72.37	60.93	72.13	75.52	68.37	72.36	70.68	73.01	66.6
September	62.65	58.26	66.02	62.23	63.20	56.38	62.09	59.31	63.75	59.85	60.25
Average	67.26	68.63	70.66	65.65	70.16	68.45	68.08	67.39	69.00	65.25	65.56
Rainfall (Inches) *											
June	2.15	1.20	3.57	2.13	2.22	1.58	3.44	1.54	3.14	2.5	3.41
July	1.34	2.83	2.17	1.47	1.83	2.92	3.06	1.34	1.83	2.58	1.36
August	1.80	2.58	.83	3.43	2.19	1.46	3.67	1.05	2.18	3.52	3.53
September	1.99	2.80	2.02	.61	1.10	3.83	1.37	2.63	.97	1.34	1.4
Total	7.28	9.41	8.59	7.64	7.34	9.77	11.54	6.56	8.12	9.94	9.70
Annual	17.31	19.14	18.62	18.03	14.74	15.55	23.25	15.03	15.91	16.92	20.92
Yield per Acre (Bushels) †											
Non-irrigated Counties											
Thomas	76	100	44	97	61	88	88	70	70	72	83
Arthur	70	110	50	80	58	80	80	56	76	60	95
Kimball	158	110	74	100	61	77	80	82	67	97	125
Cheyenne	98	116	47	99	55	71	78	56	77	66	100
Lincoln	81	100	53	103	60	90	68	82	74	56	96
Garden	98	122	62	120	95	116	91	80	92	82	110
Average	97	108	55	98	65	87	81	71	78	72	102
Irrigated Counties											
Morrill	188	141	115	140	150	110	115	120	130	140	145
Scotts Bluff	263	172	135	163	164	140	115	137	170	174	175
Average for all counties in western District	129	120	72	113	88	96	88	85	93	83	116
Increase in average yield due primarily to irrigation	32	12	17	15	23	9	7	14	15	11	14

* Data compiled from reports of the United States Weather Bureau and coöperative stations at nine places.

† Data compiled from "Nebraska Agricultural Statistics" issued coöperatively by U. S. Dept. of Agriculture and Nebraska State Board of Agriculture, Lincoln, Nebraska.

Western District

The yearly variations in the yield of potatoes per acre in the non-irrigated counties of the western district correspond closely to those of the northwestern district. However, the average summer temperatures and the July and August temperatures in the former were usually higher than those in the latter while the seasonal rainfall was generally less; consequently, a slightly lower yield per acre prevailed in the western district (Figs. 4 and 5 and Tables 1 and 2).

During the eleven-year period, 1917–1927, there were two years, 1920 and 1927, in which the decrease in summer rainfall was accompanied by an increase in the yield per acre in the western district (Fig. 5 and Table 2). In 1920 the yield per acre was 98 bushels. The average sum-

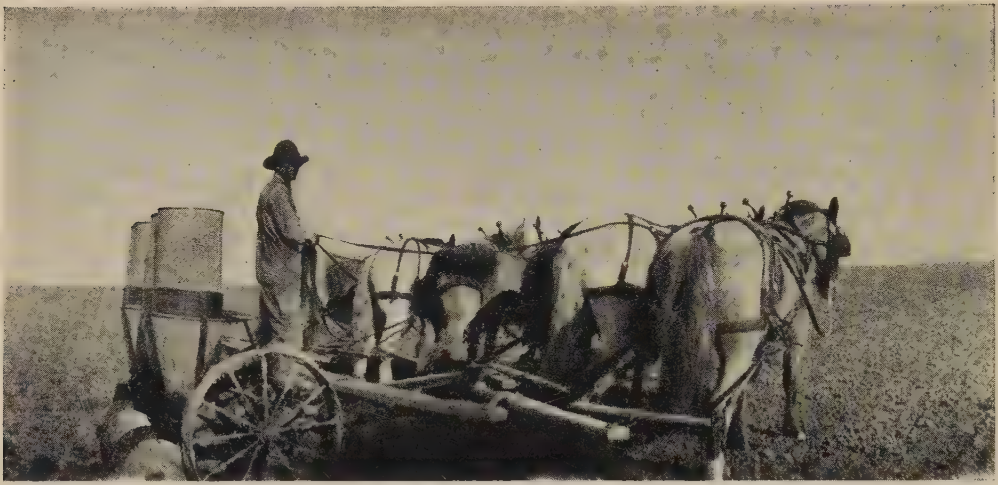

FIGURE 6.—After the soil has been carefully prepared, the two-row potato planter is used on a number of the large potato-growing farms in western Nebraska. Sixteen to twenty acres per day can be planted by one man and six horses. Six to seven bushels of seed potatoes are planted per acre. (Courtesy of Kenneth Pruden, Hemingford, Nebraska.)

mer temperature was 65.65° F., while the seasonal rainfall was only 7.64 inches, but much of it occurred during July and August, the important growing months. In 1927 a general cool growing season with a moderate, well-distributed rainfall caused an increase in the yield per acre.

During this same period, the years 1923 and 1926 showed a decrease in the yield per acre even though there was an increase in rainfall. The temperature in July and August, 1923, was relatively high and the moisture was fairly heavy; these conditions were favorable for the development of diseases which undoubtedly reduced the yield. In 1926, the climatic conditions were very similar to those of 1923 and in addition an early freeze caused a decrease in the production.

The importance of moisture in potato growth is shown by the contrast in the yield per acre in the irrigated and non-irrigated counties (Table 2). In Scotts Bluff and Morrill counties, where irrigation is practiced, the yield averaged from 110 to 263 bushels per acre during the last decade. When these two counties are included, the average production per acre in the western district is increased from 7 to 32 bushels. The maximum differences usually occur in the years when the summer rainfall is lightest.

Since the western potato-producing region lies within the area having a summer temperature of 64° to 70° F. and since the rainfall during the growing season is usually more than 8 inches, potatoes of high quality can be produced upon the uplands although the yield per acre is not as high as in the irrigated areas.

RELATION OF RAINFALL TO THE SIZE OF SEED POTATO PIECES IN THE DRY-LAND REGION OF WESTERN NEBRASKA

As a general rule more stems and a greater yield will result when large seed pieces are planted. The size of the seed pieces is very important in areas having low rainfall because a small seed piece may lose too much moisture if the soil is dry in the spring. It also has insufficient stored plant food to produce a strong plant with a good root system under droughty conditions. When the seed piece is large, a good-sized plant can be supported by the reserve food until the roots become established and can obtain moisture from the soil. The large seed pieces will also produce higher yields per acre because they increase the set (Fig. 6).

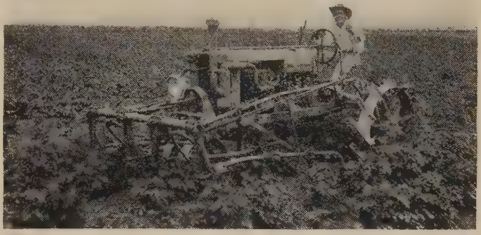

FIGURE 7.—A two-row, power-driven potato cultivator used in a 120-acre field of dry land certified seed in Kimball County. Power machinery is replacing horse-driven implements and is used on many of the farms. (Courtesy of Glenn Hunt, Kimball, Nebraska.)

TABLE 3

AVERAGE TEMPERATURE AND TOTAL RAINFALL, MAY TO AUGUST, AND THE AVERAGE YIELD PER ACRE IN THE CENTRAL CLIMATIC DISTRICT OF NEBRASKA, 1917–1927

						Temperature (Fahrenheit) *					
Month	*1917*	*1918*	*1919*	*1920*	*1921*	*1922*	*1923*	*1924*	*1925*	*1926*	*1927*
May	56.6	63.22	57.75	58.3	62.12	61.29	57.99	53.87	58.68	65.48	59.98
June	67.22	73.83	66.48	69.52	74.10	72.6	69.49	67.08	71.8	72.00	67.63
July	76.42	72.94	77.7	74.83	76.81	72.71	74.42	71.29	75.42	76.4	73.91
August	71.02	75.85	72.5	69.21	73.8	76.74	71.6	73.4	73.4	75.37	69.94
Average	67.81	71.46	68.61	68.96	71.71	70.83	68.38	66.41	69.82	72.31	67.84
Average June and July	71.82	73.38	72.09	72.18	75.45	72.65	71.95	69.18	73.61	74.2	70.77
						Rainfall (Inches) *					
May	4.85	4.7	2.8	3.45	5.39	3.43	6.59	1.92	1.79	2.37	2.47
June	2.37	2.2	4.82	3.08	1.61	2.37	5.07	5.29	3.91	1.89	3.38
July	1.18	2.82	3.98	3.23	4.33	4.53	2.42	5.9	2.11	2.70	1.39
August	1.94	2.4	1.51	4.59	2.39	2.46	5.10	5.68	3.69	5.15	3.08
September	3.63	1.02	1.22	1.47	2.11	.9	4.62	2.06	1.44	3.49	2.9
Total	13.97	13.14	14.33	15.82	15.83	13.69	24.84	20.85	12.94	15.60	13.22
Annual	21.69	22.44	25.11	25.76	21.62	20.18	30.87	25.00	20.54	21.42	22.06
						Yield Per Acre (Bushels) †					
County											
Buffalo	100	91	56	131	75	110	75	130	95	93	124
Custer	90	56	37	97	43	76	68	100	64	35	102
Dawson	82	56	55	105	68	110	73	116	92	70	106
Greeley	79	68	41	97	47	90	63	90	76	34	93
Hall	83	45	48	105	65	75	61	107	58	37	106
Valley	100	79	40	100	57	93	54	105	58	36	105
Merrick	95	38	45	97	54	97	72	113	53	41	80
Nance	87	50	48	91	51	106	73	120	72	55	80
Boone	85	67	50	93	52	104	70	97	77	49	94
Howard	99	60	47	99	50	82	70	107	60	35	90
Average	90.0	64.0	46.7	101.5	56.2	94.3	67.9	108.5	70.5	48.5	98

* Source of data: Reports of the U. S. Weather Bureau and coöperative stations at nineteen places.

† Data compiled from "Nebraska Agricultural Statistics" issued coöperatively by United States Department of Agriculture and Nebraska State Board of Agriculture, Lincoln, Nebraska.

The most desirable seed pieces should weigh between 1½ and 2 ounces. A large crop is obtained by planting 12 to 16 bushels of tubers per acre. The seed should be placed approximately 18 inches apart in the row. This method produces more stems from large pieces and inspection for disease can be made more effectively than if the plants are crowded. Rouging, removing diseased and undesirable plants, is easier and more accurate in such fields (Fig. 7).

CENTRAL REGION

As stated previously the [illegible] region is the principal source of early table stock for eastern Nebraska. The growing season for potatoes in this area is from May to August; hence the May temperature and rainfall data are included in this study (Fig. 8 and Table 3).

Despite the early planting of the crop, the temperature variations are among the principal climatic factors affecting the yield. The high yields per acre during the period, 1917–1927, occurred in 1917, 1920, 1922, 1924, and 1927, when the average temperature from May to August was 69° F. or less and the June and July temperature average was lower than 72° F., except in 1922. In that year the mean seasonal temperature increased to 70.83° F. because the August temperature was 76.74° F., but the June and July averages were not high, hence the crop was nearly ripe before the advent of high August temperature. The highest yield per acre, 108.5 bushels, occurred in 1924 when the thermal optimum for potato growth was reached, the average temperature from June to August being 66.41° F. while the June and July average was 69.18° F. These were the lowest mean summer temperatures during the entire period.

The years having the low yields per acre show a mean summer temperature of 69° F. or more while the average temperature for June and July was greater than 73° F., 1919 and 1923 excluded. The lowest production during the decade occurred in 1919 even though the June-August temperature average was 68.61° and the June and July average was 72.09° F. The cool May and June together with moderate rainfall caused a good growth of foliage but the July temperature of 77.7° F., the highest from 1917–1927, and the relatively heavy precipitation were conducive to the growth of plant diseases which reduced the yield. In addition the low rainfall of August was not sufficient for good tuber growth. The thermal conditions in 1923 were favorable for a higher yield than occurred. However, the low May temperature (57.99° F.) and the abundant moisture of that month (6.59 inches) caused some of the seed to decay and thereby reduced the stand. This was followed by an unusually heavy rainfall and a very warm July which were favorable conditions for losses by plant diseases and insects.

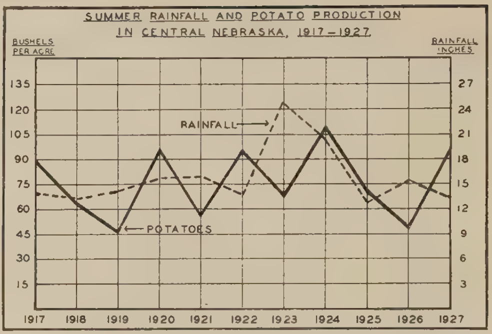

FIGURE 8.—The fluctuations in the yield per acre in the central district are not as closely related to summer rainfall as are those in the western region. High seasonal temperatures are more important in the variations in the yield in the central area than in the western part of the state. (Based upon U. S. Weather Bureau reports, and statistics by Nebraska State Board of Agriculture, Lincoln.)

The effects of both high temperatures and unevenly distributed rainfall are represented in the yield of 1926. The production was 48.5 bushels per acre, or the second lowest from 1917–1927. The low June and July rainfall, together with a high July temperature, retarded plant growth while the high August precipitation of 5.15 inches was too late for the development of a heavy yield.

The summer moisture throughout the eleven-year period was ample for good potato crops as the mean seasonal rainfall varied from 13 inches to 24 inches. The above studies indicate that temperature is a more important climatic factor than rainfall in potato production in central Nebraska.

In conclusion the western potato-growing region lies in an area having a mean seasonal temperature of 64° to 70° F. with practically no hot days or high temperatures in July or August, while the central region is in a less favorable thermal district because the average seasonal temperature is usually from 67° to 72° F. and the June or July temperatures frequently exceed 72° F. The seasonal rainfall in the central region, however, is greater and more certain than that of the western region; hence, the former has the better moisture conditions while the latter has the more favorable temperatures for successful potato production (Fig. 9).

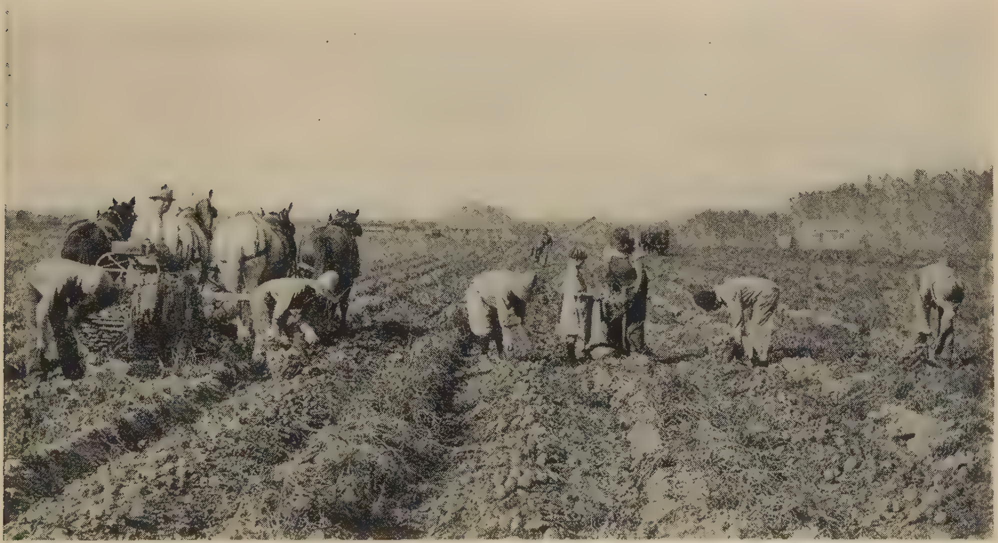

FIGURE 9.—A potato picking scene in the North Platte valley of Nebraska. Potatoes are removed from the ground by a digging machine after which members of the family or hired help place the tubers in sacks. The yields in this region vary from one hundred to three hundred or more bushels per acre. Four horses are required for most of the potato diggers. (Courtesy of Lyman Andrews, Great Western Sugar Co., Scotts Bluff, Nebraska.)

SOIL CONDITIONS

The soils of western Nebraska are particularly well adapted to the production of potatoes because they have a relatively high percentage of sand, important in the development of the size and the shape of the tuber. The best soils are the sandy loams of the table lands and those in the valleys of western Nebraska. These usually contain sufficient plant food for the growth of potatoes. They are slightly sandy and generally have porous subsoils which give good underground drainage. In central and eastern Nebraska the soils are of finer texture and heavier and are not so well adapted to potato growth as are the soils in the western part of the state. However, large areas of sandy soils suitable for potato production are available along the Platte, Missouri, Republican, and Elkhorn rivers (Fig. 10).

Comparing the average annual yield per acre in typical counties in each of the three major soil regions in Nebraska; namely, the high plains, the sand hills, and the loess region, the highest average yield per acre was in the high plains (Table 4).

During the period 1917–1927 the annual yield per acre in this region was 86 bushels, and if the counties—Scotts Bluff, Sioux, and Morrill—in the irrigated section are included, the average yield was 105 bushels. The yield in these irrigated counties was 145 bushels per acre. The sandhills show an average annual production of 77 bushels per acre during the same period as compared with 73 bushels per acre in the loess region.

However, these statistics do not show the actual bearing capacity of [illegible] the three regions because climatic conditions also influenced the yield (Table 4).

The production per acre in the sandhills may be higher one year than that in the loess region, and during the next year reverse conditions exist, as, for instance, in 1918 the average yield per acre in the sandhills was 110 bushels, while that of the loess region was only 59 bushels. Favorable climatic conditions in the loess region will result in average yields of more than 90 bushels per acre as was the case in 1920, 1924, and 1927.

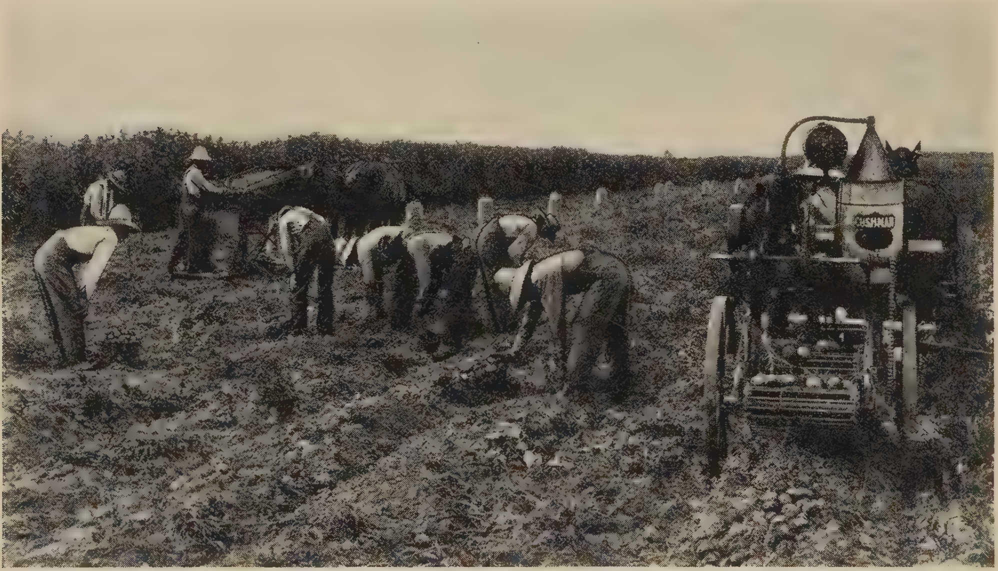

FIGURE 10.—Digging, picking, sorting, and sacking potatoes in the North Platte valley north of Morrill, Nebraska. A gasolene engine is used to dig the potatoes; thus, the use of only two horses is necessary instead of four as is shown in Figure 9. The potatoes are picked by hand and placed in wire baskets or pails and are then put in the sorting machine which sorts and sacks the tubers. A new machine which automatically digs, picks, sorts, and sacks potatoes was used in Nebraska fields in 1928. This field produced 300 bushels per acre. (Courtesy of Conservation and Survey Dept., University of Nebraska.)

The soils of the high plains region are better adapted to potato growth because they are not as extremely sandy as those of the sand hills, nor are they of as fine texture as the loessial soils. This results in a medium-textured, friable soil, particularly suitable for the growth of well-formed, good-sized potatoes.

If the rainfall in the high plains was as heavy as that in central and eastern Nebraska, these soils would

TABLE 4

AVERAGE ANNUAL YIELD OF POTATOES* (BUSHELS) PER ACRE IN THE THREE SOIL REGIONS OF NEBRASKA, 1917–1927 †

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
HIGH PLAINS											
Non-irrigated Counties											
Box Butte	85	111	48	91	80	50	80	46	95	90	107
Dawes	96	119	51	94	86	76	79	56	106	89	109
Sheridan	125	120	40	91	86	81	73	47	105	92	106
Kimball	158	110	74	100	61	77	80	82	67	97	125
Cheyenne	98	116	47	99	55	71	78	56	77	66	115
Average (Yearly)	112	115	52	95	74	71	78	57	90	87	112
Irrigated Counties											
Sioux	118	103	120	147	145	112	110	105	140	153	149
Scotts Bluff	263	172	135	163	164	140	115	137	174	174	175
Morrill	188	141	115	140	150	110	115	120	130	140	145
Average (Yearly)	190	139	120	147	153	121	143	121	146	156	156
Average Yield in High Plains	141	124	66	114	97	87	91	81	112	113	129
SAND HILLS REGION											
Grant	50	110	43	80	60	83	81	50	75	61	93
Hooker	91	117	45	75	63	90	73	60	75	70	85
Arthur	70	112	50	80	58	80	80	56	76	60	95
McPherson	85	105	46	92	61	75	65	58	80	68	98
Cherry	90	117	48	91	80	50	80	46	95	75	92
Thomas	76	100	44	97	61	88	88	70	70	72	83
Average (Yearly)	77	110	46	86	64	78	78	60	79	81	91
LOESS REGION											
Dakota	106	80	65	131	66	131	83	130	53	84	110
Boone	85	67	50	93	52	104	70	97	77	49	94
Adams	89	41	47	105	58	60	61	91	49	33	90
Lancaster	77	31	81	42	54	63	70	90	33	49	70
Thayer	59	29	37	103	49	50	71	84	44	41	80
Richardson	76	63	45	61	46	54	90	125	44	65	73
Buffalo	100	91	56	131	75	110	75	130	95	93	124
Hall	83	45	48	105	65	75	61	107	58	37	106
Average (Yearly)	84	59	53	96	58	81	73	93	57	56	93

* The importance of rainfall in the yield of potatoes per acre is indicated in the high yields per acre in the high plains and in the sand hills region in contrast to the yields in the loess region in 1918. During that year the rainfall was heavy in the western region while it was unusually low in eastern Nebraska.

† Data compiled from "Nebraska Agricultural Statistics" issued coöperatively by United States Department of Agriculture and Nebraska State Board of Agriculture at Lincoln, Nebraska.

‡ The following data may be of interest: average, 1917–1927, non-irrigated counties in High Plains, 86 bushels; average, 1917–1927, irrigated counties in High Plains, 145 bushels; average, 1917–1927, in High Plains, 105 bushels. The average, 1917–1927, in Sand Hills Region was 77 bushels, while that in the Loess Region was 73 bushels.

produce higher yields than they do at present and would be likely to exceed those of the loessial soils.

NEBRASKA CERTIFIED SEED POTATOES

Nebraska has developed a high position as a source of certified seed potatoes for the southern states and the Bermuda Islands. The quality of the seed tubers produced in the dry land areas of the high plains is very high, and the demand for Nebraska seed is now greater than the supply. The seed potatoes mature rapidly in the southern states and produce plants usually quite free from disease. Experiments conducted in Louisiana, Texas, and Arkansas show that Nebraska seed potatoes are superior to those of most of the northern states in that they show less disease than others, and produce a higher yield per acre.

During a four-year period, the results of experiments of using Nebraska certified seed at the Louisiana Experiment Station averaged in primes 144.6 bushels per acre, with only 7.9 per cent mosaic disease. Fifteen lots of Nebraska certified seed were tried. These produced approximately 45.3 per cent more than the seventeen lots of uncertified seed which were used as checks. The amount of mosaic in the checks was 47.5 per cent. During the same four-year period sixteen lots of Wisconsin certified seed averaged

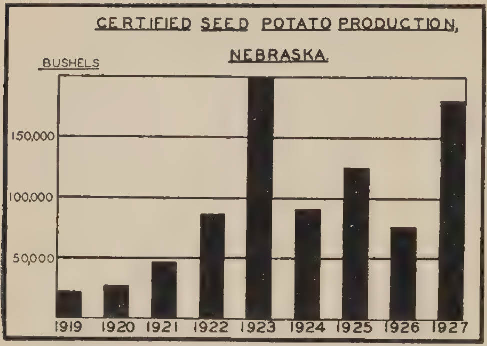

FIGURE 11.—Certified Seed Potato Production has increased from 20,000 bushels in 1919 to 181,500 bushels in 1927. The heavy crop in 1923 caused a surplus of potatoes which resulted in low prices, hence the low production in 1924. The value of using certified seed potatoes in the southern potato-growing regions during the last few years has now increased the demand for northern-grown seed potatoes. The production in 1926 was lower because an unusually early freeze in western Nebraska caused a heavy loss in the yield. (Based upon statistics by Nebraska State Board of Agriculture, Lincoln.)

139.8 bushels of prime potatoes per acre, which was an increase of 40 bushels per acre average over the checks of uncertified seed. The average per cent of mosaic was 23.9 in the certified potatoes.[1]

The Nebraska certified potatoes are raised from carefully selected seed, treated for disease before planting. The crop is rouged two or three times during the season in order to remove plants which are diseased or not suited for seed. The tubers thus produced are relatively free from disease because they are carefully grown on the uplands in a relatively cool, dry climate.

Diseases such as the mosaic and spindle tuber are carried by insects, especially the sucking type, as the plant lice, which live in moist and warm climate. Other diseases are more easily carried by water in the ground. As a result, the potatoes produced in the higher, dry land areas are of higher quality and are in greater demand for seed than are those grown in the irrigated districts and in the warmer, more humid sections of the eastern and central parts of the state.

The Nebraska seed production has increased from 20,000 bushels in 1919 to 181,500 bushels in 1927 (Fig. 11). The annual yield during that period averaged 94,000 bushels.

The principal markets for Nebraska seed are in Texas, Louisiana, Oklahoma, Georgia, Mississippi, Alabama, Florida, and Tennessee, Texas being the most important consumer and Louisiana second. Some seed has also been sold to the Bermuda Islands (Fig. 12). From 3,500 to 4,400 carloads are shipped annually from the principal shipping points in Nebraska. Approximately 78 to 85 per cent of the carlot shipments originate in the six leading potato-producing counties in the western part of the state.

The price received for Nebraska certified seed potatoes is usually one dollar or more per hundred weight than for table or uncertified seed. In 1927 the farmers received two dollars more per hundred pounds than for common potatoes and the price was one dollar greater per hundred weight than for the certified seed from other states.

Approximately two hundred carloads of certified seed potatoes were shipped from Nebraska in 1927 and reports indicate that about four hundred carloads were marketed during 1928 (Fig. 13).

As a response to the demand by the southern growers for seed for early planting a method has been developed which causes potatoes to sprout and grow more rapidly. It

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[1] Professor G. L. Tiebout, Department of Horticulture, University of Louisiana, Baton Rouge, La., Fifth Annual Report, Nebraska Potato Improvement Association, 1923.

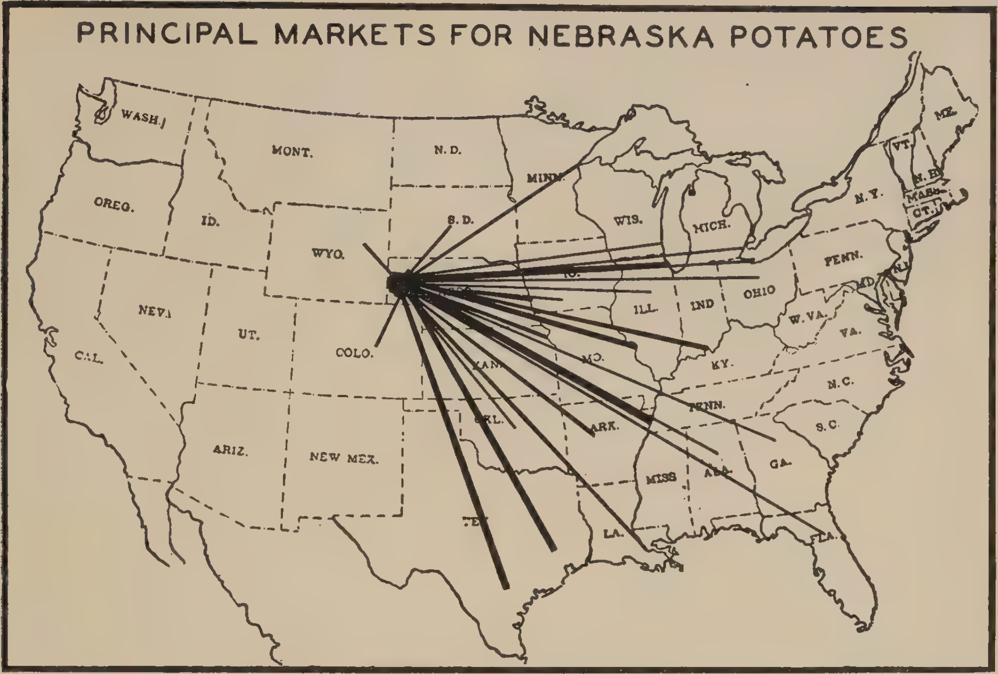
PRINCIPAL MARKETS FOR NEBRASKA POTATOES
WASH.
MONT.
N.D.
MINN.
ME.
VT.
N.H.
MASS.
CT.
N.Y.
OREG.
ID.
S.D.
WIS.
MICH.
WYO.
IO.
PENN.
NEV.
UT.
COLO.
ILL.
IND.
OHIO
MD.
W.VA.
VA.
CAL.
KAN.
MO.
KY.
N.C.
TENN.
OKL.
ARK.
S.C.
ARIZ.
NEW MEX.
MISS.
ALA.
GA.
TEX.
LA.
FLA.

Figure 12.—Principal markets for Nebraska potatoes, both Certified Seed and table stock. Some of the principal cities receiving potatoes from Nebraska are Chicago, Memphis, Omaha, St. Louis, Kansas City, Houston, and Dallas. (Based upon U. S. Bureau of Agr. Economics reports, and statistics by Nebraska State Board of Agriculture, Lincoln.)

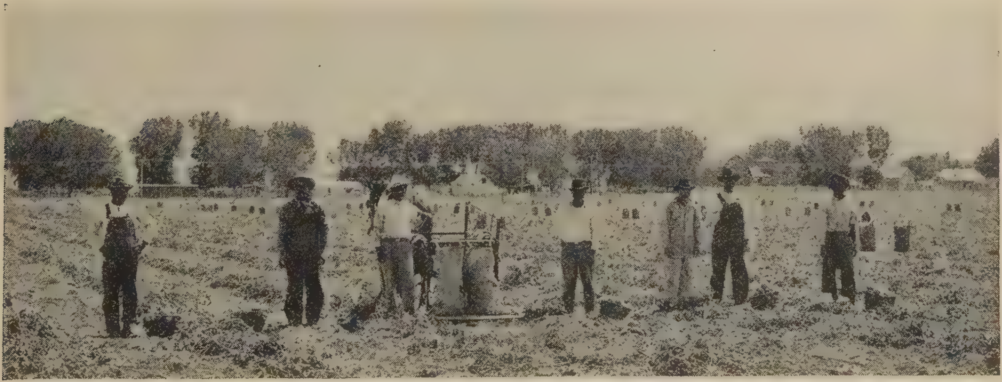

Figure 13.—A scene showing sacked potatoes ready to be hauled to the storage cellar or market. Mexicans and Indians are among the potato pickers employed in western Nebraska. The sorter and sacker, which is moved about by a horse, makes the filling of sacks easier and quicker. Potato pickers usually pick from 95 to 110 bushels per day. Some Indians pick as high as 135 to 145 bushels per day. (Courtesy of Lyman H. Andrews, Great Western Sugar Co., Scotts Bluff, Nebraska.)

is generally known that potatoes must have a period of rest for two or three months before they will start to grow. In early October, 1927, twenty to twenty-five carloads of Nebraska certified potatoes were treated with ethylene chlorohydrin after which they were shipped directly to Florida and to the Bermuda Islands and there planted immediately. Certified potatoes which had not been treated were

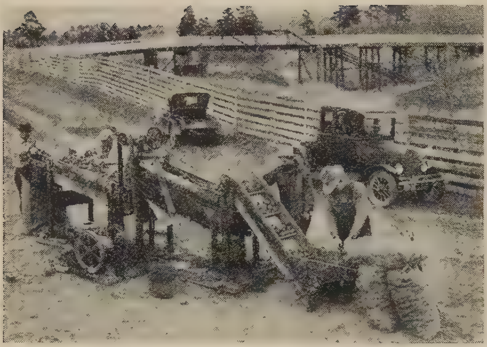

FIGURE 14.—A sorting machine which sorts and sacks potatoes in preparation for the market. In many fields the sorting is done at the same time as the potatoes are picked. (Courtesy of Conservation and Survey Dept., University of Nebraska.)

planted at the same time. The results were that plants from the treated tubers were appearing above the ground by the latter part of October while the others did not come through the soil until six weeks or two months later. The treatment is a real factor in potato production in the south where growers must have seed to plant in the early winter. With this method of crop raising, new potatoes may be available on the market continuously because they can be grown at all times in the southern states, and with this treatment, it will no longer be necessary for the seed to be stored for a length of time before it will sprout and grow (Fig. 14).[2]

PRODUCTION AND VALUE

The average annual acreage of potatoes from 1919–1927 was approximately 96,000 and the production was 7,903,000 bushels. The annual value of potatoes per acre during the last nine years was $89.02 and held second place among all crops in Nebraska while sugar beets ranked first at $95.69 per acre. These were followed by tame hay at $24.89, wheat at $18.11, and corn at $16.92 per acre (Fig. 15). Thus, although the acreage of potatoes is not large compared with the total acreage of wheat, corn, and tame hay, the value per acre is greater.

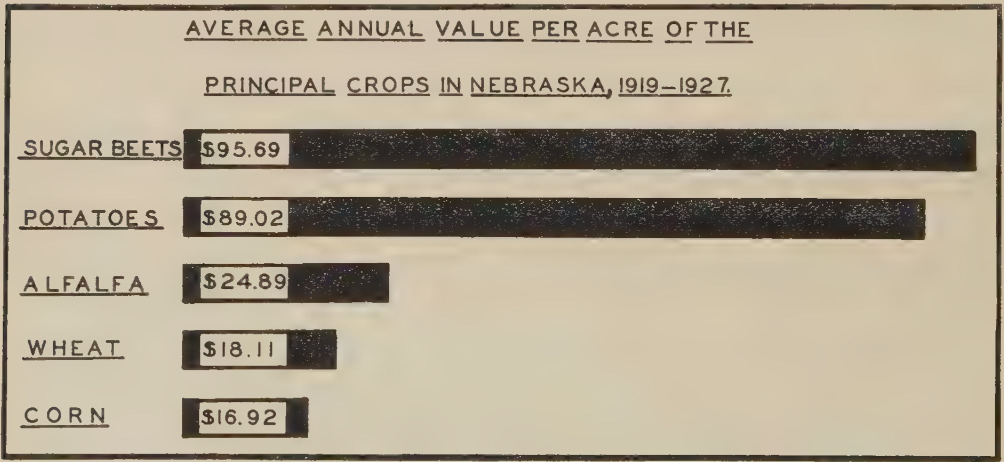

FIGURE 15.—The value of potatoes per acre was second of all crops in Nebraska, being surpassed only by sugar beets. (Based upon statistics by Nebraska State Board of Agriculture, Lincoln.)

Potatoes are important as an element in crop rotation. Increased yields of crops following potatoes continue several years because care-

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[2] Report of Mr. H. O. Werner, Department of Horticulture, University of Nebraska, Lincoln, Nebraska.

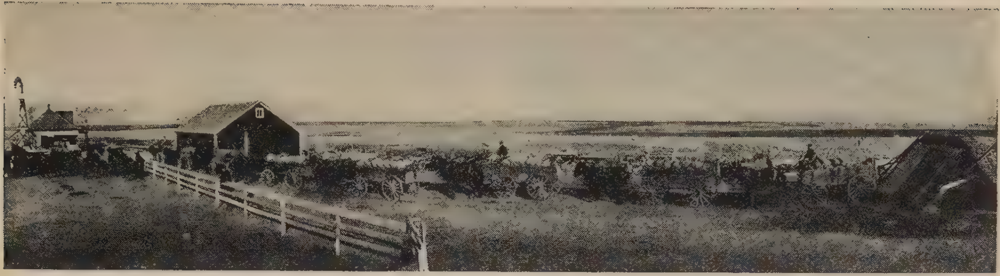

FIGURE 16.—Hauling sacked potatoes from the storage cellar to the car or market. Note the entrance to the potato cellar. Horses are the principal sources of power for hauling potatoes. However, trucks are used extensively for haulage in some of the areas. (Courtesy of Kenneth Pruden, Hemingford, Nebraska.)

ful tillage results in a good condition of the soil and the fertility is increased by the addition of considerable organic matter from decayed roots and plants. In some instances when prices are low and the potato crop is financially a failure, the added fertility which increases the yield of grain crops counteracts the loss.

The rotation of crops also decreases the percentage of disease in potatoes. The yield of potatoes grown in different rotations at the Scotts Bluff Experiment Station show that potatoes grown in the following rotation—oats; (manure); beets; alfalfa; alfalfa; alfalfa; potatoes—had the highest yield per acre (363 bushels) and were fairly free from scab while continuous potato cropping showed a low yield of scabby tubers.[3]

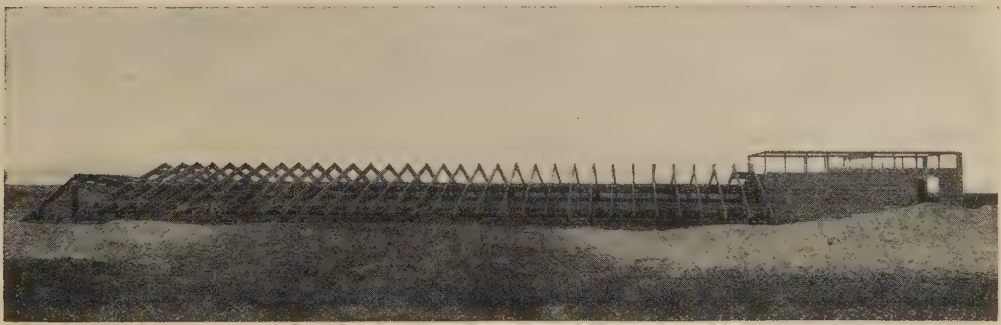

FIGURE 17.—The construction of a large potato storage cellar in western Nebraska. The capacity of these cellars varies from two thousand to approximately seventeen thousand bushels. The wire lying across the rafters is covered with straw or grass and dirt to make the cellar warm. A door is placed at each end. The one to the left is sealed with straw and dirt after the potatoes have been stored. The one to the right is in a covered house which is made of tile or close construction in order to shut out the low temperatures of winter. Some cellars have only one door which makes it necessary to back the wagon in one direction. (Courtesty of Conservation and Survey Dept., University of Nebraska.)

SHIPPING CENTERS

The average annual shipments of commercial potatoes in Nebraska from 1919–1927 were approximately 2,400,000 bushels of nearly 3,500 carloads.[4] From 78 to 85 per cent of the carlot shipments originate in the six leading potato-producing counties of western Nebraska (Fig.

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[3] Report, Nebraska Potato Improvement Association, 1920, page 13.

[4] Nebraska Agricultural Statistics, 1926, issued coöperatively by the United States Department of Agriculture and Nebraska Department of Agriculture at Lincoln, Nebraska.

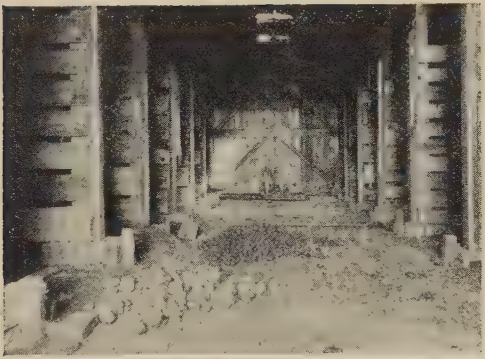

FIGURE 18.—Interior of a very good farm potato cellar. Each bin holds four hundred or more bushels. The double walls between the bins and ventilators make good ventilation. This type of cellar is very common in the potato districts of western Nebraska. (Courtesy of Nebraska Farmer, Lincoln, Nebraska.)

16). In Sheridan and Dawes counties, the principal shipping points are Gordon, Hay Springs, Rushville, Marsland, from which approximately 600 to 700 carloads are shipped annually. An annual output of 850 to 900 carloads of potatoes were marketed from Hemingford and Alliance in Box Butte County. The principal loading centers in the irrigated region are Morrill, Mitchell, Henry, and Scotts Bluff from which 1,500 or more carloads of table stock are shipped annually (Fig. 17).

From 150 to 200 carloads are marketed from the north central district in Brown County, the chief shipping points being near Ainsworth.

Approximately 700 to 800 carloads of early potatoes are marketed from Kearney, Gibbon, and Buda in the central region. Shipments start about the middle of July and average from 15 to 20 carloads per day from July 15 to September. Eastern Nebraska and Chicago are the leading markets.

Some of the principal cities receiving Nebraska potatoes in 1927 were Chicago, 350 carloads; Memphis, 334 cars; Omaha, 348 cars; St. Louis, 246 cars; Kansas City 159, and Houston, 93 cars.[5]

Summarizing, the western and central districts are the most important producing and shipping regions of both seed and table stock, while eastern Nebraska, the middle, and southern states are the important consuming centers (Fig. 18).

CONCLUSION

The best potato crops in Nebraska are produced in the western part where the mean summer temperature is 66° to 68° F. and the July or August temperatures do not exceed 72° F. When the seasonal temperature is greater than 68° F., or the mid-season average is high, the production per acre is usually from 20 to 35 bushels less than in cooler seasons. Although the temperatures during the day are often high in this section of the state, the nights are cool, which factor causes less transpiration and aids the plants in storing the food. In contrast, the climate in eastern Nebraska is more humid, the temperatures during the day are quite high, and the nights are usually warm—conditions ideal for corn production; hence corn is better adapted to the climate in the eastern part while potatoes are more suited to that in the western part. The summer rainfall is generally ample in all areas for potato culture, but it is usually insufficient in the western region for corn production.

Inasmuch as the climate and soil conditions of western Nebraska are most favorable for potato growth, the major part of the commercial crop will continue to be produced in that part of the state.

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[5] U. S. Department of Agriculture, Bureau of Agricultural Economics, 1928, Washington, D. C., and "Nebraska Agricultural Statistics."

The demand for Nebraska Certified Seed potatoes in the southern states and in the local markets makes the outlook for the expansion of the industry very promising. These, together with the favorable physical conditions for potato growth, will not only result in larger crops, but also in the production of higher-quality potatoes.

AGRICULTURE IN THE DRY REGION OF THE U. S. S. R.[1]

N. M. Tulaikov

Director, Agricultural Experiment Station, Saratov, U. S. S. R.

THE various regions of the vast Union of Soviet Republics differ greatly in their physical character and their types of farming. Among these the Dry Region that borders the Black Sea on the north, includes the lower and central Volga Valley, and extends eastward to the Altai Mountains in Central Asia, offers some of the most difficult problems in adjusting agriculture to the physical conditions.

BOUNDARIES OF THE DRY REGION

From the agricultural standpoint, the name "dry region" is applied to those areas of deficient rainfall and high summer temperatures where ordinary agricultural methods frequently fail to produce a crop. There are, of course, no definite natural boundaries to dry regions, for types of farming, as well as types of climate, gradually change. In the southern U. S. S. R., agriculture, in general, becomes unstable where the average annual precipitation is below 400 millimeters (16 inches); consequently, for the purposes of this paper, the isohyetal line of 400 millimeters is made the northern boundary of the Dry Region.[2] Yet even this isohyet is not everywhere accepted as the boundary, since in the Asiatic part of the U. S. S. R. the southern limit of chernozem (black-earth) soils is made the boundary, conditionally, and the eastern boundary is not extended beyond the Altai Mountains. Sufficient knowledge of the exact boundaries in these areas is not yet available.

If we accept these boundaries on the north, the extent of this Dry Region would be approximately as follows: the European part begins with the narrow strip at the western borders of the U. S. S. R. along the shores of the Black Sea; this strip gradually widens to the northeast, where it includes the southern portion of the chernozem zone, or what the soil experts designate "Southern Chernozem." To the south it embraces the chestnut brown to light gray, semi-arid soils, which were formed under conditions of considerably less precipitation and more insolation than the true black-earth soils to the north.

The isohyet of 400 millimeters of annual precipitation, which is adopted conditionally as the northern border of the Dry Region, passes a little south of Kharkov, Voronej, Tambov, and Penza. The line then follows north of Ulianovsk and Samara, circles around the foothills of the Ural Mountains near Ufa, and then goes east into Siberia. As has been previously stated, the northern boundary of the Dry Region in Siberia follows the southern limit of chernozem soils. This boundary passes a little north of Petropa and Omsk to the foothills of the Altai Mountains. South of this boundary nearly the entire area in the U. S. S. R has the characteristics of the Dry Region, *i.e.*, climatic conditions, and locally soil conditions, also, unfavorable to crop production in greater or lesser degree.

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[1] Translated by J. W. Pincus.

[2] In the Great Plains Region of North America the isohyets trend from the north to the south, where the evaporation is much greater and the rainfall more torrential, hence no single isohyet can be used to bound the dry regions in the United States. In the U. S. S. R., on the other hand, the isohyets trend east and west in the same general direction as the isotherms.

In the foothills and tablelands of the Tian-shan, in the foothills of the Pamir-Altai, in the Hindu Kush, and in part of the Kopat-Daga, which form the political boundary of the U. S. S. R. along the east and south, is situated a strip of land having 250 millimeters or slightly more precipitation per year. Accepting, provisionally, that it is impossible to grow crops without irrigation where the annual precipitation is less than 250 millimeters, and also accepting provisionally that in most of these foothills the annual precipitation is 250 to 400 millimeters, these lands appear suitable for dry farming, where the lay of the land permits.

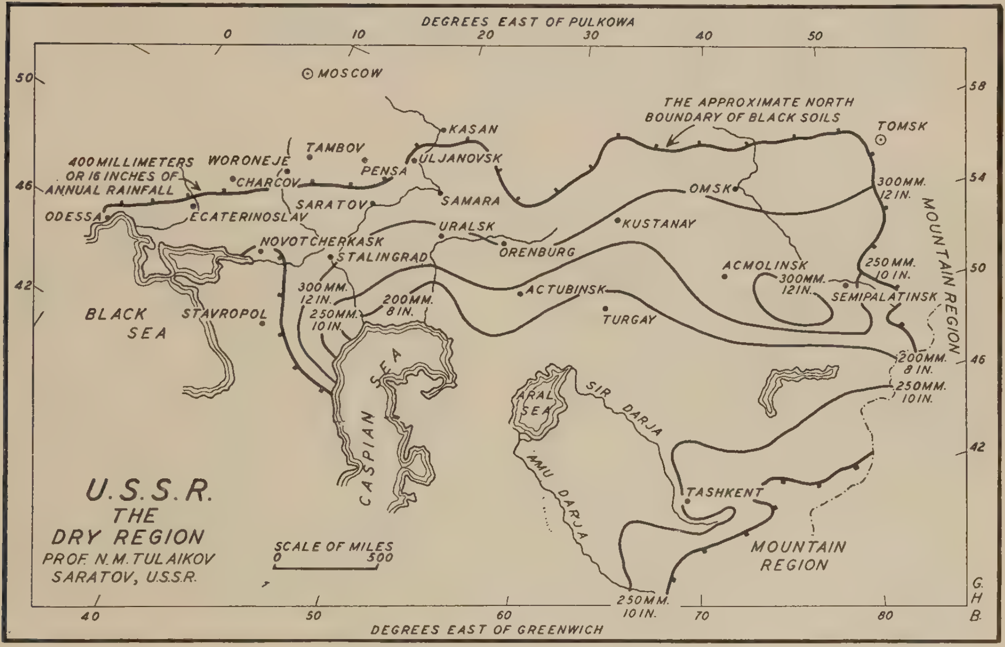
DEGREES EAST OF PULKOWA
0
10
20
30
40
50
50
46
42
58
54
50
46
42
MOSCOW
KASAN
THE APPROXIMATE NORTH BOUNDARY OF BLACK SOILS
TOMSK
TAMBOV
400 MILLIMETERS OR 16 INCHES OF ANNUAL RAINFALL
WORONEJE
PENSA
ULJANOVSK
CHARCOV
SARATOV
SAMARA
OMSK
300 MM. 12 IN.
ODESSA
ECATERINOSLAV
URALSK
KUSTANAY
NOVOTCHERKASK
STALINGRAD
ORENBURG
ACMOLINSK
250 MM. 10 IN.
300 MM. 12 IN.
SEMIPALATINSK
MOUNTAIN REGION
300 MM. 12 IN.
250 MM. 10 IN.
200 MM. 8 IN.
ACTUBINSK
TURGAY
BLACK SEA
STAVROPOL
200 MM. 8 IN.
250 MM. 10 IN.
ARAL SEA
SIR DARJA
AMU DARJA
CASPIAN
TASHKENT
MOUNTAIN REGION
U.S.S.R.
THE DRY REGION
PROF. N. M. TULAIKOV
SARATOV, U.S.S.R.
SCALE OF MILES
0
500
250 MM. 10 IN.
40
50
60
70
80
DEGREES EAST OF GREENWICH
G. H. B.

Figure 1.—The relation of the rainfall to the soils, natural vegetation, and agriculture of much of the richest crop-producing area, particularly in the dry-farming regions of Russia is peculiarly significant. On this map the isohyets within the Black Soil Belt reveal this significant and intimate relation.

Within these boundaries the total area of the Dry Region may be roughly estimated at 5,400,000 square kilometers (2,100,000 square miles). This is about one-fourth of the total land area of the U. S. S. R.

The Central and Lower Volga Areas

The wide variation in physical conditions within this vast region, as well as the almost complete lack of knowledge of large parts of the Asiatic portion, particularly of Kazacstan, formerly known as Kirghisia, make it difficult to describe accurately or adequately all this territory and the various agricultural methods employed. It is safe to state, however, that in districts where the annual precipitation is less than 250 millimeters there can be no crop production without artificial irrigation. Such districts can be utilized only for pasturing livestock, perhaps only for nomad grazing, and for this reason they will not be considered in this discussion.

In the remainder of the Dry Region, where the annual precipitation varies from 250 to 400 millimeters, farming can and must be organized along definite lines that are distinct from ordinary agricultural practice in humid regions. As sufficient data are not obtainable from the scientific experimental institutions in the Asiatic part of the Soviet Union, this discussion will be confined to the systems of dry farming in the central and lower Volga areas, which have been more thoroughly investigated, than other parts of the region.

This part of the Dry Region is typical in its nature and its methods of farming, and therefore may well represent the whole Dry Region. Its agriculture has both definite, positive and negative features. The history of colonization and agriculture, moreover, is almost a history of development throughout the Dry Region, not due to accident but to the influence of geographic conditions. However, the Volga area is farther advanced in development. Local inconsistencies between the physical habitat and the types of farming occur in this type area, and similar discrepancies may reasonably be expected to develop in the Asiatic and other portions of the Dry Region. Sufficient material is obtainable from the local experiment stations in the Volga area which have been in operation for a number of years, to provide a diagnosis of the ills of the local agriculture and to evaluate the farming in the future. The agriculture of the Asiatic part of the Dry Region is likely to pass through the same stages that the Volga area has passed

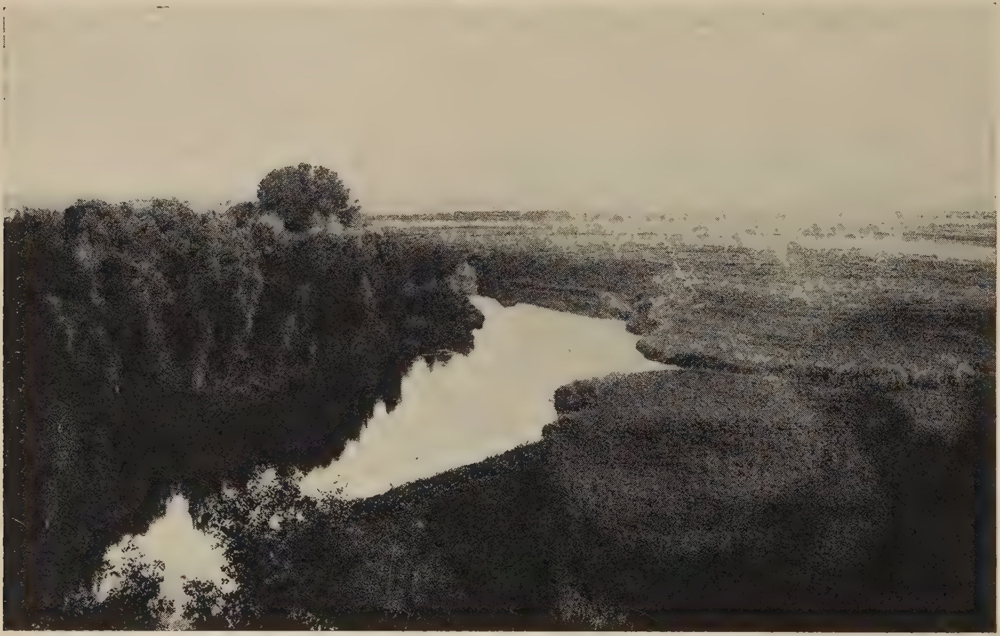

FIGURE 2.—Only along the rivers of the steppes is there any arborescent vegetation. For miles between the streams not a trace of tree or shrub of any size is evident.

FIGURE 3.—The steppes of the Northern Caucasus reveal the same monotony of landscape as elsewhere in Russia, miles and miles of open grassland country.

through, and correct systems of farm organization in the Volga area should serve as an example to the farmers in those Asiatic sections of the Dry Region which have not yet been investigated.

PRINCIPAL CHARACTERISTICS OF THE VOLGA AREA AND ADJACENT LANDS

The southwestern part of former European Russia, which embraces the central and lower Volga area, beginning with Samara Province and including a portion of the present Northern Caucasus and all the southern Ukraine, has distinct physical characteristics which influence specifically the methods of agriculture employed. Moreover, these methods are very similar throughout.

Soils

The soils in these areas vary from the fertile chernozem (black soil) to the infertile shifting sand which blows along the steppes and covers, at times, the better soils of the region. Between these two extremes there are many grades and varieties of soils. It is unnecessary to discuss in detail the characteristics of these soils. Although they differ greatly, they have one common and distinctive characteristic—their youth. They are all grassland or desert soils, not leached as are most soils in humid regions; and as all have been cultivated only recently, they are still naturally rich in plant food and require scarcely any fertilization.

Under natural conditions in the Dry Region, the yield of the crops is determined not by presence of the plant food elements in the soil, as is the case in the central and northern parts of the Soviet Union, but by the quantity of the rainfall and of moisture in the soil. With a low moisture content, the yield of crops under ordinary methods of cultivation by peasants cannot be very high, and partly for this reason the fertility of the soil cannot quickly be exhausted. If the yields should increase notably the problem of maintaining soil fertility, particularly in some of the soils, might, after a few decades, become pressing. However, at the present time, the question of the fertility of soil in the Dry Region

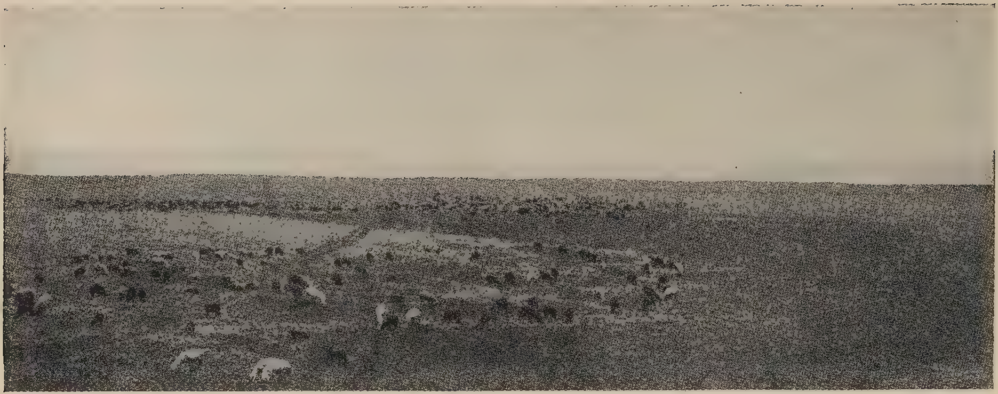

Figure 4.—Great areas of the drier steppes have not been broken by the plow for years. These are occupied solely by nomadic herds and flocks grazing the rich grasses, watering at the widely scattered waterholes or the widely separated streams.

cannot become an important problem.

Notwithstanding the variety of the soils in these dry regions, they are nearly all suitable for agriculture, except the sandy soils that blow or drift badly after plowing. In addition to the general richness in plant food, most of the soils are easy to till. Only the soils on the left shore of the lower Volga in the former counties Novouzensk and Nikolaevsk, of the Province of Stalingrad, are heavy and require much breaking, particularly after they have been fallowed or kept in sod. Locally there are also some soils unfit for agriculture, the so-called "solonzi" (solonetz), or alkali meadows, which abound throughout the lower Volga regions, particularly on the left shore. Though occasionally this type of soil occurs in the holdings of peasants, it is usually not cultivated, as there are still sufficient better lands available.

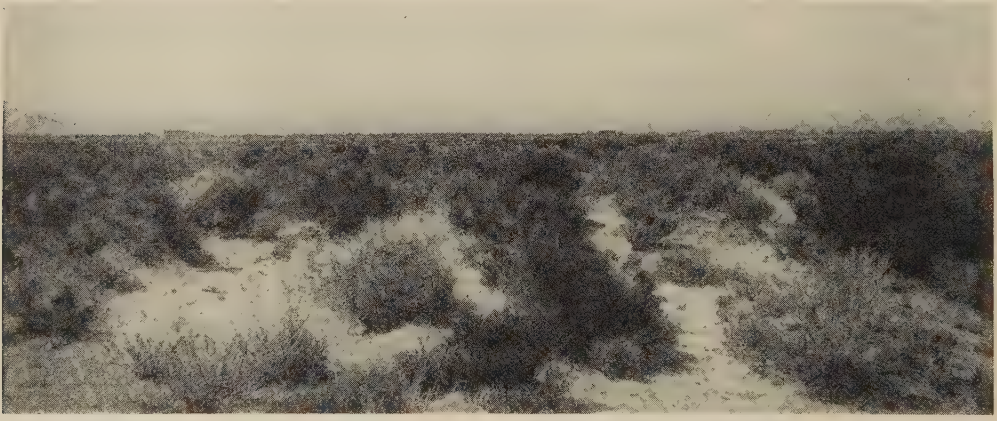

Figure 5.—In Kazakstan, extensive stretches of alkali steppes, more or less sparsely clothed with salt desert type of vegetation, some of it palatable and nutritious grazing, constitute a conspicuous part of the landscape.

Climate

Since in practically all portions of the Dry Region the temperature is sufficiently high for crop production, the moisture conditions exert the dominant influence. In studying these moisture conditions, not only

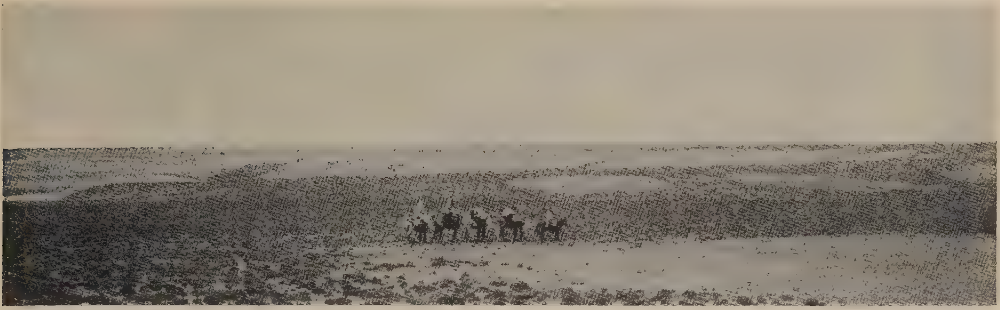

FIGURE 6.—A stretch of alkali desert in the more arid regions, with desiccated pools and flats encrusted with mineral salts, interspersed among the patches of low salt bush vegetation.

the quantity and the areal distribution of the rain or snow, but also the manner of occurrence and seasonal distribution during the year must be considered.

In the Dry Region of the Soviet Union the annual precipitation is considerably less than in other agricultural portions of the U. S. S. R. In other regions producing grain, where the crops do not frequently suffer from drought, the annual precipitation is from 400 to 600 millimeters (16 to 24 inches) annually. In many of the districts of the Dry Region, and particularly of the Volga area, agriculture is practiced where the annual precipitation is only from 250 to 300 millimeters (10 to 12 inches), or one-half to one-third that of the northwestern agricultural regions. However, investigations conducted during many years by the agricultural experiment stations in this region prove that the main difficulty is not the small total annual precipitation, for if it could be properly utilized, and if it came at the proper time, it would be sufficient for securing fairly good crop yields. But, the rains fall irregularly and there are often long intervals between rains. Occasionally, in exceptionally dry years, there is no rainfall during the periods when it is most necessary for the development of the crops.

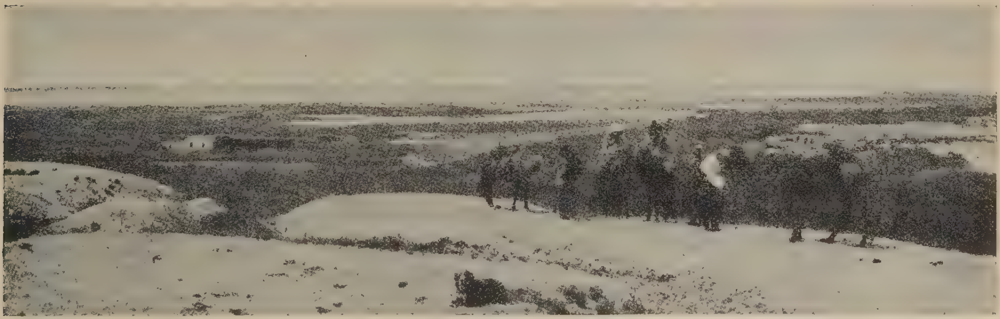

FIGURE 7.—Another view of the broad stretches of barren alkali lands, bare and glaring under the summer sun, desolate and dangerous under the gray skies and biting winds of winter, but affording considerable pasturage in the interspersed patches of desert shrub and grass.

This irregular and capricious distribution of rainfall during the year is characteristic of the Dry Region. Early spring rains shortly after seeding of spring grains are essential for the farmer, but it may happen, as, for example, in 1921 and 1924, that from the beginning of the spring until the harvesting of the spring wheat, there was very little rain, and the plants had to subsist on the supply of moisture in the soil stored during the fall and winter months. Only in cases where the soil had been tilled properly was there a sufficient supply of moisture to produce even a meagre crop.

In addition to the lack of precipitation, particularly during the growing season, hot, dry summers have serious effects. This peculiarity of the climate, however, has some advantages, for hay and grain dry rapidly, and almost without difficulty. Nevertheless, the heat and the dryness of the air force both the cultivated and wild plants to evaporate the soil moisture very rapidly, leaving so little in the soil that the plants wilt and sometimes die.

Finally, the so-called "zapali," "zachvati," and "mgli" (sandstorms, dust mists, etc.), which are almost unknown to the peasants in the central part of Russia, frequently occur in the Dry Region and diminish greatly the yield of spring grains, sometimes destroying the crop.

On the other hand, the peculiar climate of these regions bestows some benefits. The products are usually of higher quality, that of wheat being richer in protein, one of the most valuable constituents. Melons yield luscious fruit. Forage crops abound in rich nutrients on which it is easy to fatten meat-producing animals. If all these favorable peculiarities of climate could be utilized, and if the farmer could adapt himself to the unfavorable conditions, farming could then be made very profitable, as is proved by the agricultural experiment stations.

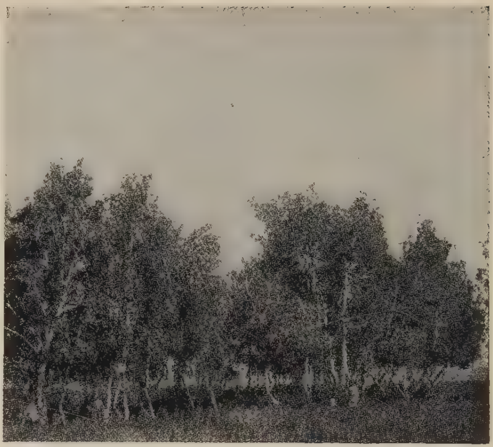
FIGURE 8.—Birch woods in Kazakstan where a bit of better-watered terrane and diminished evaporation permit the establishment and growth of an arborescent cover, particularly toward the northern border.

Approximately one-fourth of the yearly precipitation in the Volga Region falls in winter in the form of snow, but frequently the snow does not cover the soil as the constant winds blow it off from the fields into the ditches or woods. Because of the general lack of moisture for the growth of farm crops, methods of holding the snow in the fields (by leaving stubble, etc.), so that it can be utilized afterward by the cultivated plants are very helpful. But in some parts of the region it is claimed that the increased crop yields that result scarcely repay the cost of holding the snow in the fields. Nevertheless, under certain conditions it is practicable and even necessary to do so if a permanent agriculture is to be maintained in these regions. Experiments at the Saratov Agricultural Experiment Station show that holding the snow on the fields has, under favorable conditions, created a deep penetration of moisture into the soil, and this in turn exerts a distinct influence on the development and yield of plants, particularly during dry years, tending to equalize the yields from year to year. The holding of snow appears to be the simplest method of increasing crop yields in this Dry Region, and it is a method available to every peasant.

CHARACTERISTICS OF DROUGHT

What is drought and what are its characteristics from the standpoint of the farmers in the Dry Region? In order to obtain an answer to this question some data of the experiment stations in the Volga area must be studied.

Meteorological

The years of crop failure usually are years of low precipitation. However, not all years with low precipitation result in crop failures, as can be proved by numerous examples within the memory of the peasants in the region. For example, the year 1909 had the lowest precipitation in the decade in Samara Province, but the crop yields were almost the highest in the history of the province. The explanation lies in the time when the precipitation occurred.

Normally, according to the averages of many years' records, the precipitation in March is low, increases in April and still more in May, and reaches the maximum during the summer months of June, July, and August. In the fall, during September and October, the precipitation diminishes, and the minimum occurs during the winter months of December, January, and February. For example, the following table shows the average monthly precipitation for many years at the Experiment Station near Bezenchuksk in the Province of Samara.

FIGURE 9.—A flat sandy valley where the short bunch grass vegetation characteristic of the drier portions of the American high plains affords nutritious, though scanty, pasturage for the wandering herds and flocks.

Month	*Millimeters*
January	13.6
February	11.6
March	13.6
April	22.8
May	38.1
June	46.5
July	43.2
August	47.8
September	37.1
October	26.9
November	30.8
December	16.1

Notwithstanding that the July precipitation is not of much use to the spring grain crops, particularly wheat (since growth is almost complete by this time), this seasonal distribution of rainfall insures an average, if not a high yield, particularly if the diversification of crops is practiced.

Individual years differ greatly from the average in the quantity and time of precipitation. Often during April, May, and June, the most important period of plant development, the precipitation may be so low that it plays no part in the growth of the plants. The moisture in the soil in these cases gradually, but markedly, diminishes, the temperature of the air and soil rises, and there results exceptionally unfavorable conditions for the proper growth of the plants. From early spring until July 15, 1924, on a very extensive area in the Volga sub-region there was practically no rain, and thus the plants had to utilize the supply of moisture which was already in the soil. As this supply was limited, not all plants could persist. The spring grains could not take root, as the soil was exceptionally dry, and the crop was practically a failure.

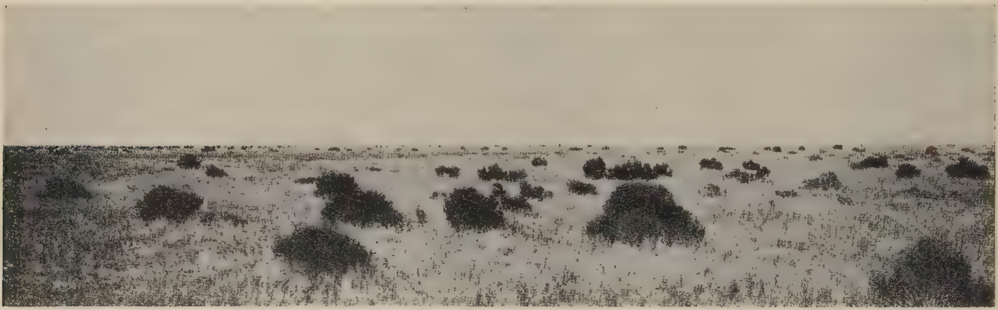

FIGURE 10.—A shrub-dotted steppe in Saksaul, where more dependable rainfall permits the growth of widely scattered shrubs and a dense covering of nutritious grasses.

During the summer precipitation is only one, although a very important, factor in plant growth. On account of the heat and the dryness of the atmosphere during a drought, the plants are forced to evaporate more moisture, in order to lower their temperature and thus equalize, to a certain extent, the difference in the amount of moisture between the air and themselves. The inability of the soil to replace this water causes the plants to perish long before they mature. The lack of moisture in the air is often the immediate cause of the decrease in plant growth during drought, and this fact must be taken into consideration in devising methods of combating drought.

DROUGHT AND THE CROPS

This unfavorable combination of a dry spring and a hot summer affects some crops more than others. Winter rye and winter wheat develop usually a sufficiently deep root system to withstand fairly well the spring drought, although it affects somewhat the yield. But with the spring grain crops, particularly spring wheat, the results are more serious. If the early sown spring wheat germinates well, the drought quickly dries out the upper layers of the soil, and the small wheat plant cannot develop its root system. The secondary roots of the wheat plant are unable to take root in the dry layer of soil, and the plant remains with only its primary root, which cannot supply it with sufficient moisture.

This rooting of wheat is a very critical period, and if roots are not formed at the proper time, the crop cannot be assured. For spring

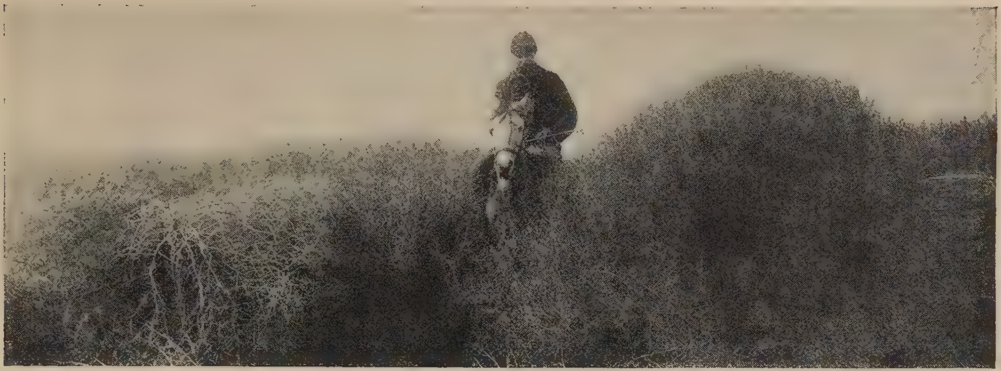

FIGURE 11.—A growth of *Salsola kali* where the steppes have been irrigated. The fertile soil when thus adequately watered produces heavy yields of crops, but such weeds as this also develop luxuriantly unless great care and labor is expended in restraining them.

wheat, of all crops, the spring drought is most dangerous, as it determines the crop. The effect on the other spring grain crops, oats and barley, is only a little less serious.

The case is quite different for that group of plants that are called cultivated or row crops, such as corn, sorghum, sunflower, proso-millet, and sugar beets. Most of these crops make a very slow and weak growth in the spring, and for this reason the early spring drought does not affect them very much. They develop rapidly in June and July, when the temperature of the air rises considerably, and it is usually about this time that the spring drought is broken. If there has been a pronounced lack of rain during the spring, they start growth near the end of June or beginning of July, which is usually too late for early spring grain. Thus, starting growth in the early summer, these cultivated plants are able fully to utilize the summer precipitation which is of practically no use to the spring grain. Almost the same can also be said of the other cultivated crops, particularly of the perennial hay and fodder crops. Usually the latter develop rapidly on the moisture which remains in the soil in the spring, and are ready for a cutting by the middle of June. Then, utilizing the rains of June and July, they grow rapidly during the warm season of the year.

FIGURE 12.—Saratov District Agricultural Experiment Station, one of its experimental fields in the foreground. This station is the central institution for the study and development of the Dry Regions and their agriculture.

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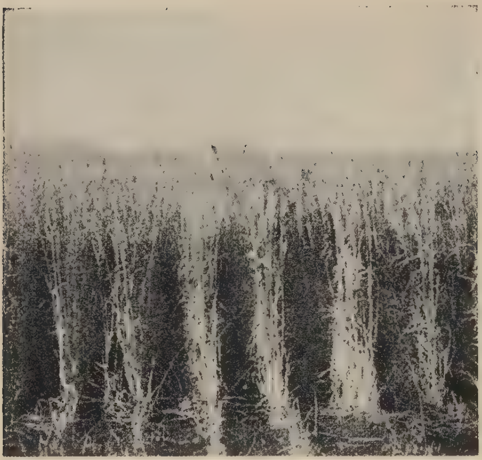

FIGURE 13.—Spring wheat planted in wide drills in order to make the best use of the scanty moisture supply in the fertile soil.

At times drought continues until June and even July. In this case again the crops most injured are the spring grains, particularly spring wheat. Under normal weather conditions, the heads of spring wheat fill in the second half of June, but if the weather is very dry and hot, the grain of the wheat becomes shriveled and the yield rapidly diminishes.

It is evident that absence of precipitation in spring and high temperature in early summer are very destructive only to one group of crops—the spring grains. For this reason such drought is most destructive in those regions where these crops, principally, are grown. In all the Dry Region, and particularly in the Volga area, the main crops, until very recently, have been spring wheat and other spring grains. It is partly for this reason that this region has so often suffered from drought. In this region there have now been developed new methods of combating drought. These consist principally in adapting the crops and the method of farming to the climate of the region.

CROP PRACTICES AND DROUGHT

The year 1924 afforded an interesting comparison of the difference in the condition and yield of grain on the fields of the experiment stations and on the neighboring peasant fields. In all cases it was clear that on the fields of the Experiment Station, with exactly similar soil and weather conditions, there was a considerably greater yield of spring and winter grains than on the adjoining peasant fields. In many instances the yield on the fields of the Experiment Station was two or three times that of the peasants' fields. Why should this difference exist?

In the first place, the Experiment Station fields are carefully cultivated, and, as a result, the soil has acquired improved physical characteristics, particularly the ability to hold more moisture, and better aëration. The experimental fields were also freer from weeds, which take much moisture from the soil. These conditions permit the crop plants to feed better. Besides, these fields were plowed at the proper time, harrowed before seeding, and seeded with varieties of wheat and other crops suitable to the local conditions. Quite the contrary is observed on the adjacent peasant fields. Irrational tilling of the soil, untimely and poor plowing, seeding with poor and weedy seed, on fields already badly infested with weeds—this is a fair picture of the ordinary grain farming in the Volga area. In fields which have been poorly plowed and not at proper intervals, there is insufficient moisture to grow a crop.

Of course, it happens occasionally that the spring wheat on the experimental field cannot stand the adverse weather conditions and gives very low yields, sometimes as low as two to three quintals per hectare (three to four bushels per acre), but in such cases the adjacent peasant field usually produces no crop at all. Even if it cannot be said that the experimental fields always produce good yields of spring wheat, it may be said that a complete failure can be avoided by using proper seed and correct methods of cultivation.

CAUSES OF CROP FAILURE IN THE VOLGA AREA

Within the memory of the present generation the Volga area several times has suffered terribly from complete crop failures. Many remember the year 1891 when the crop failure embraced a very large area of former southeastern European Russia, and the government had to take special measures of relief to save the population from starvation. The droughts in the years 1901 and 1906 were less extensive, but the crop failure of 1911 recalled the horrors of 1891. As this crop failure occurred, however, after two years of good crops, the population withstood it fairly well. Nevertheless, government and private relief were again necessary, and special attention was paid to the local methods of agriculture.

After a series of favorable seasons, war and revolution diverted the attention of the people from agricultural improvements, but the two successive droughts of 1920 and 1921 in the Volga Region again compelled consideration of the difficulties confronting this region. Only three years had passed when the terrible drought of 1924 again afflicted the greater part of the Volga Region, and again the question was asked, "What are the causes of the drought, and how can these destructive conditions be overcome?"

It is the belief of the people that the droughts are becoming more frequent and severe. But there are no reasons to suppose that the climate has changed during the last decade, or even during the past century. Undoubtedly, droughts occurred in the past, but evidently they were not remembered by the population, perhaps because the fewer people depended more on pastoral products in early years, and they were recorded in the official history of the region only when the damages to agriculture were very extensive and noticeable.

In the history of the agriculture in a given locality, particularly in a dry region, there can be noticed at a certain density of population what appear to be harmonious relations

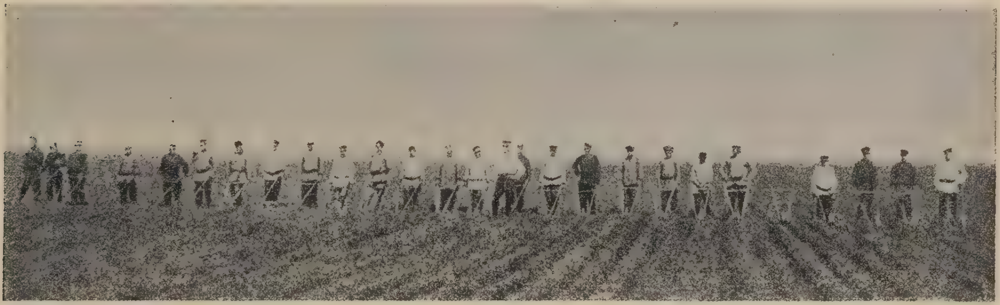

FIGURE 14.—"Planet" cultivators in use in the hand-cultivated areas of the steppes where labor is abundant and cheap, and capital and other power scarce.

FIGURE 15.—"*Komplexnia*" steppe, one of the widely distributed types in contrast with "*Kompekovskaia*" steppe.

between the natural conditions of the region and the type of agriculture. In these cases agricultural practices in a given territory harmonize so closely with the natural conditions and with the agricultural economics of the whole country, that occasional sharp changes of natural conditions from normal do not disturb greatly the economic balance, nor the life of the people. This is particularly true of the primitive methods of agriculture formerly practiced in the Volga Region.

FIGURE 16.—"*Kompekovskaia*" (*Atriplex canum*) steppe, as contrasted with the "*Komplexnia*" steppe.

As was noted above, early spring grains, and particularly early spring wheat, are the least resistant grains in this region to spring droughts. In the lower Volga area, which includes the provinces of Samara, Saratov, Stalingrad, Astrakhan, Ural, and the present German Volga Republic, the census of 1926 showed 7,300,000 hectares of crops as follows:

Crop	*Hectares*	*Per Cent of Total Area (Approximately)*
Winter Rye	1,695,000	23
Spring wheat	3,996,000	55
Oats	417,000	7
Barley	408,000	6
Proso-millet	296,000	4
Sunflower	124,000	1.5
Other crops	300,000	5

These figures indicate that about 93 per cent of the total crop area in 1926 was occupied by grain crops, the yields of which under the peasants' methods of farming depend upon the rainfall in the spring and early summer (April, May, and the beginning of June). If there is no rain, there is certainly to be a short crop or a complete failure. The higher the temperature and the less the rain during the month of May, the more certain is the crop failure. If timely rains fall in May, the yields of grain on peasant holdings are almost assured without any special effort.

This characteristic uncertainty of the crop yield on the peasant lands is well known to all the peasants in the dry Volga Region. Knowing their dependence on the weather during the spring, many of the peasants found it possible and profitable to insure themselves against ruinous crop failures by providing a surplus of grain for themselves, and of hay and fodder sufficient for their cattle for two or three years.

With a large area of steppe (grazing) land in the Volga Region, and a small population, a large acreage of sown crops per farm was possible in the past. Gradually the population increased, and the crop area per peasant holding had to decrease. Economic and social conditions associated with war and revolution still further reduced the acreage per homestead, and the people were forced to consume the reserve supply of grain and fodder. With this reserve gone, the drought was felt more keenly than in the past, and in many cases it meant either starvation or abandonment of the homesteads.

The Way of Escape

Notwithstanding the adverse climatic conditions, two of the old provinces, Samara and Saratov, exported annually during the last five years before the war about 20 million quintals of grain (73 million bushels). From Samara the average yearly exports were 2.2 million quintals rye, and 12.3 million quintals wheat, and from Saratov 1.6 million quintals rye and 3.1 million quintals wheat. It is true that there were favorable crop years during this five-year period; however, one year, 1911, was very bad, and we can consider the surplus production of these provinces during this period as typical of the pre-war years.

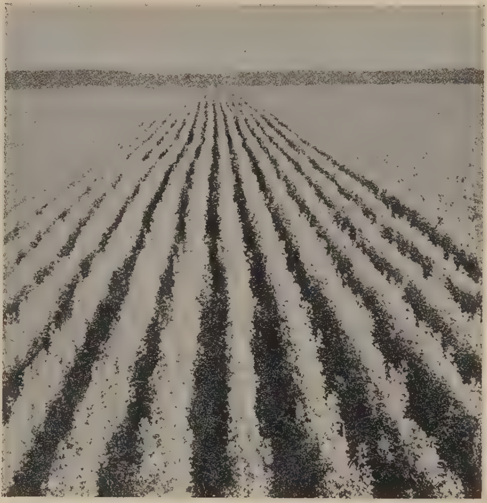

Figure 17.—First-year alfalfa planted in wide drills to conserve the moisture necessary to a good stand. When the roots penetrate deeper, the alfalfa can sustain itself well.

At the present time such a surplus does not exist, and agriculture has lost some of its stability. Naturally, one is prompted to ask, "Would it not be best to return to the pre-war conditions and thus make everything more satisfactory in the Volga Region?"

The suggestion seems simple but is impossible, and even if possible, it is better to go forward, guided by scientific knowledge, toward a rational agriculture. The crisis of pre-war agriculture in the Volga Region pointed out quite definitely that its organization was contrary to the natural conditions, as well as the changing economic conditions even before the war demanded a radical adjustment in the methods of agriculture. War, revolution, and the resultant changes in social conditions showed still more clearly the unsuitability of the prevalent methods of agriculture, and thus the problem of establishing a more stable agriculture in the Dry Region was placed before its people.

MEASURES FOR OVERCOMING THE DROUGHT

"The granary of Russia," and "the region without a future" are the two contradictory characterizations of the dry Volga Region which have been used by statesmen and technicians. During the twenty-year period from 1891 to 1911, there were in Saratov and Samara Provinces, according to the Central Statistical Bureau, three complete crop failures (1891, 1906, 1911). During this period poor yields were noted ten times in Saratov and five times in Samara, particularly in winter and spring grains (1892, 1899, 1901, 1905, 1908), and three poor crops for either winter or spring grains (1895, 1897, and 1907). In other words, in Saratov out of the twenty-year period there were only five years with good crops (1894, 1896, 1900, 1904, and 1909), and in Samara there were only ten years of good crops.

In 1924 the total gross crop in Saratov, despite the increased area, fell to 2.5 million quintals. In six counties of this province the yield during that year was so small that the crop, after deducting grain needed for seed, amounted to less than one quintal per person. In 1904 the gross crop of grain in the former Saratov Province was equivalent to 18.7 million quintals; in 1899 it reached 20.2 millions; and in 1913 23.3 million, with an average for the decade of about 13.5 million quintals. In the present boundaries of this province the average yield from 1910 to 1914 was equivalent to 9.94 million quintals. Considering the organization of agriculture that existed in the Volga area at that time, could anyone doubt the optimists who declared that this was the "granary of Russia"? Could anyone believe the statement that the region had no future?

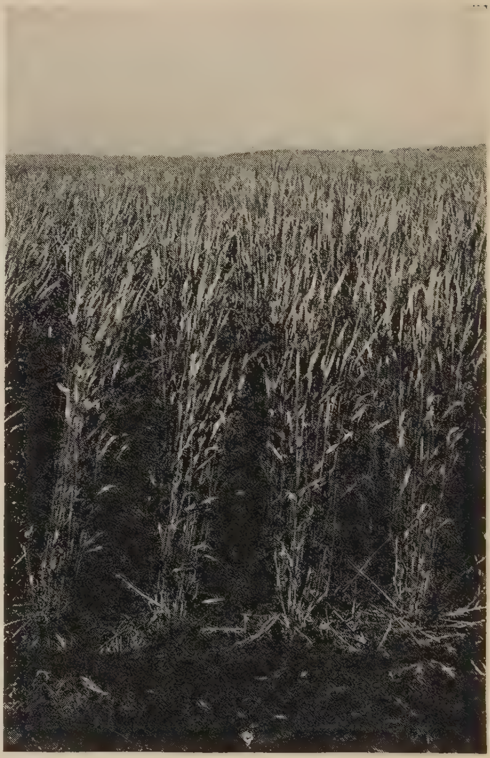

FIGURE 18.—Winter rye drilled with wide spaces between the rows. This crop occupies second place in the crop economy of the Dry Regions, and the technique of growing it is highly developed.

But it must be recalled that public assistance in years of poor crops, and tremendous exports in the years of good crops, were characteristic of the Volga area in the past as well as the present. It is clear that for many years the organization of agriculture in the area has not harmonized with the natural conditions. As previously noted there is a preponderance of small grains, which depend on occasional spring rains that frequently do not occur. This undependable cropping is carried on by very primitive methods without any attempt by the peasants to employ national methods of tillage which would increase considerably the yield of the crops.

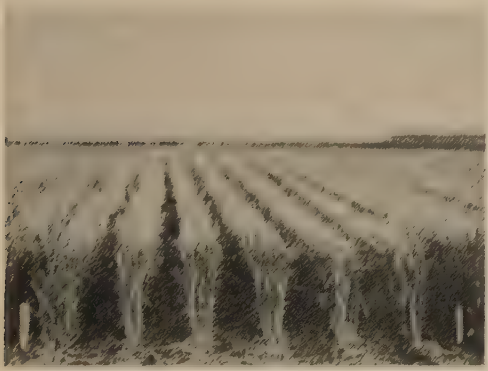

FIGURE 19.—Oats, drilled like all other grain and forage crops, in widely spaced rows.

The farmer in this Dry Region always has risked his livestock as well as his crop. Frequently there is insufficient fodder. The stock has had to be sold during droughts for a very small sum, and this has brought great hardship to the farmer. The only method of insuring against bad years or crop failures was to leave a sufficient supply of feed for stock and sufficient grain in the bins for food for one or two bad years. What would such insurance cost the individual farmer or the government? Could this assure the permanency of the agriculture of the area? The experiences of the past years are adverse to such methods of insurance. While such insurance would save the strong and well-to-do peasant, it would not help the poor peasant much, and the preservation of the poor peasant and his holdings would have to be undertaken by the government, as has been often the case in the past.

Another type of insurance against the terrible results of drought and crop failures has been proposed—the creation of irrigation districts, where every peasant would be guaranteed a minimum crop for his sustenance during dry years. Without discussing whether it is possible, from the standpoint of availability of irrigation water, to provide all the population in the dry Volga area with irrigation, without touching the question of the cost of such projects, and without raising the principal question of whether this irrigation would provide the necessary insurance, let us consider a third plan of insurance. This proposal is to create in the area a correctly organized and technically adequate type of agriculture which in its organization and technique should utilize advantageously all the complex natural conditions. It is believed that in such an organization lies a permanent and profitable agriculture.

The Soviet Government has appropriated 77 million rubles, and a beginning has been made in this colossal undertaking of reorganizing the agriculture of the dry regions on the basis of the data provided by the local agricultural experiment stations.

IMPROVED TECHNIQUE OF TILLAGE

The experiment stations and other institutions have been working mostly on problems of local farming methods. Research in animal husbandry is not so extensive. The fundamental question in crop experimental work in the Dry Region is the amount of soil moisture and the best methods of its utilization. The determination of the most efficient

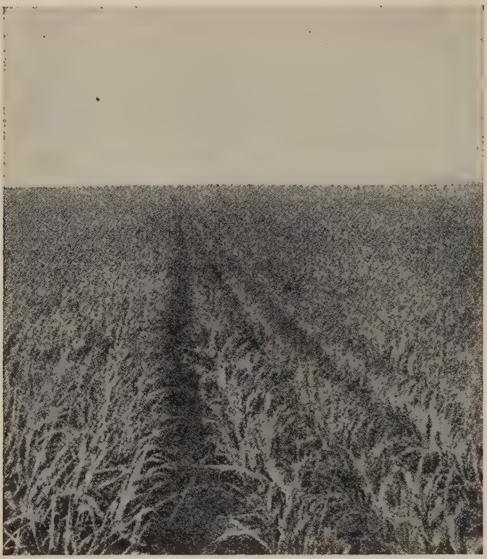

FIGURE 20.—In widely spaced rows, proso-millet is also drilled rather than sown.

methods of accumulating, storing, and using every drop of moisture is the principal goal of all the experimental work in field crops.

The methods are different in various sections, depending on the quantity and character of the precipitation. In studying these methods it was necessary to study the plant life and the way in which the plants utilized the soil moisture. It is well known that there are plants that cannot fully utilize all favorable conditions when offered, and, on the other hand, there are plants which repay the cultivator by increased yields. These plants must be found. If they are not indigenous, they must be introduced, bred, and selected after thorough study of the original plants. This is the great problem of the breeders in the Experiment Station.

The most important crop in the dry Volga area is spring wheat, the area of which in 1916 was 55 per cent of the total crop area. The average yield of spring wheat in the various provinces of the Volga area for the last thirty years before the war varied from 4.3 quintals per hectare (6.3 bushels per acre) in Samara to 5 quintals (7.3 bushels per acre) in the Don Province. In Samara Province the extremes in yields in different years varied from one quintal per hectare average for the province during a year of crop failure to 8 quintals per hectare in years with good crops. In Saratov Province, with almost the same average of 4.5 quintals, the extremes were from 1.5 to 9.5 quintals per hectare (to convert to bushels per acre multiply by 1.47).

The experiment stations in the Volga area have devoted most of their time to spring wheat. Numerous experiments with this crop at the various stations have proven that the average yield of spring wheat could be raised by simple methods to nine quintals per hectare in the greater portion of the lower and central parts of the Volga area. In the drier southwestern portions of this area the average yield cannot be raised higher than 7.5 quintals, but in the northern and northwestern parts and in the center of the province the yields could average 10 or 11 quintals. For example, at the Saratov Experiment Station during the six-year period from 1916 to 1921, the average yield of wheat sown after several crops varied from 10 quintals after wheat to 13 quintals after pumpkins, and at the Krasnokutsk Experiment Station, located in a less favorable climate, the yield for five years from 1914 to 1918 varied from 6.3 to 7.6 quintals per hectare. The yield of spring wheat can be almost doubled by simple methods, which are within the reach of every peasant.

As mentioned above, the area of spring wheat in the Volga area in

1916 was about 4,000,000 hectares (10,000,000 acres). Supposing that all the farmers of the Volga area would grow spring wheat according to instructions of the local Experiment Station, and that instead of the average yield of 4.6 quintals per hectare, they would obtain 8.2 quintals per hectare. This increased yield of 3.6 quintals per hectare would produce about 15,000,000 additional quintals (55,000,000 bushels) of grain.

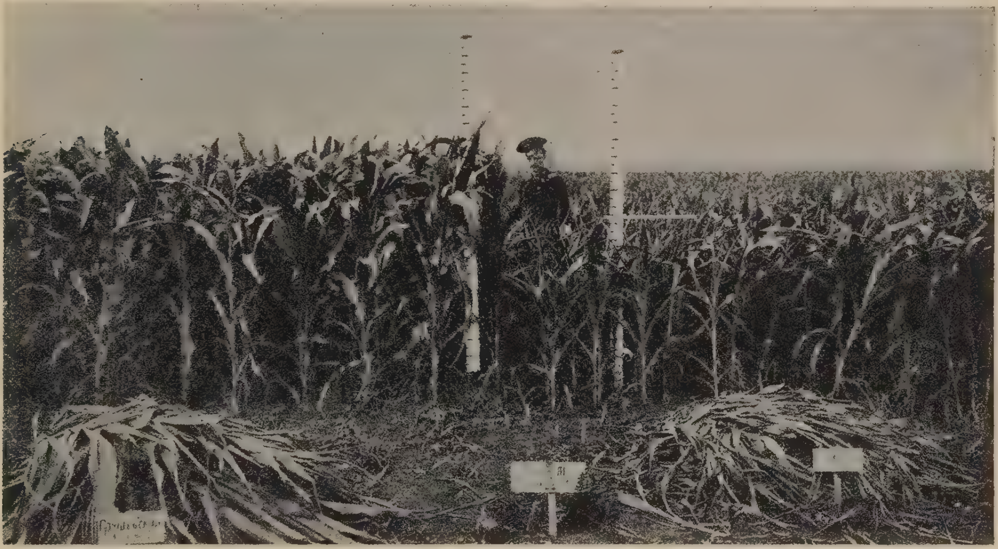

FIGURE 21.—The less densely planted corn to the right, the more closely spaced corn to the left, indicates how this forage crop responds to the small supply of moisture in the soil.

The second grain in importance in the Volga Region is winter rye, the area of which in 1916 was about 1,700,000 hectares. The average yield of winter rye in the Samara Province for the last thirty years before the war was 3.7 quintals per hectare, and in Saratov Province, 4.6 quintals. The minimum average yield of rye for Saratov Province was 0.5 quintals, and the maximum, 9 quintals. The difference between the extremes in the Province of Samara were not quite so great, but it can be seen that the acre-yield was very variable, and that yields at times approached zero. This is owing largely to the primitive methods of cultivation, which do not utilize the comparatively large amounts of rain which fall during the fallowing of the land, as well as during the growth of the crop.

The experiment stations have devoted considerable time and attention to the study of the preparation of the fallow for winter grain. It is definitely known that winter rye is well adapted to the climatic and soil conditions of the Volga Region, and the results of the different methods of cultivation are definitely established. The average yield at all the experiment stations of the Volga Region is 16.9 quintals per hectare. Taking the average yield of winter rye on peasant holdings at 5.2 quintals per hectare, the average yield of the Experiment Station is three times greater. Supposing that every hectare would have an increase of only ten quintals, the possible increase of the crop of winter rye over the present yield on the area devoted to this crop would amount to 17 million quintals. These rough estimates, of course, are subject to error, but they show clearly that the technical possibilities of this region are unusually promising. The correct methods of culture of only two of the most important crops in the region could make an enormous increase in their production, and at the same time assist greatly in increasing agricultural stability.

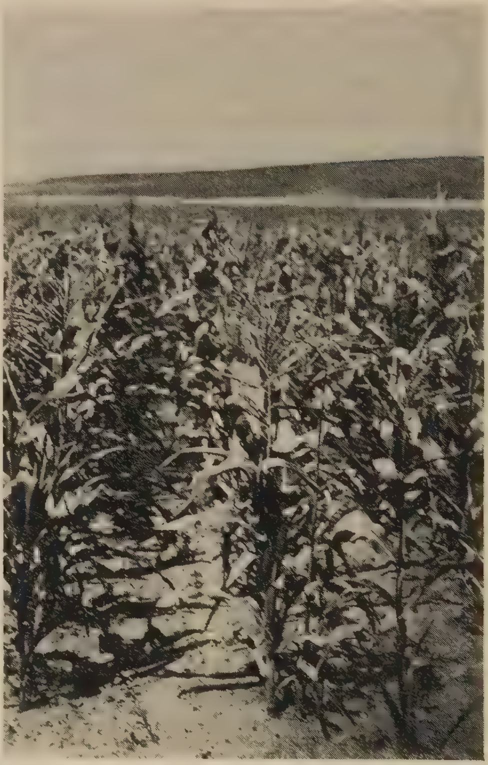
FIGURE 22.—Indian corn constitutes a most important crop over much of the dry-farming area, drought resistant varieties yielding relatively well, and affording both forage and grain resources that are invaluable to the peasants.

But the experiment stations also have data on hand which prove that the farmers of this region can depend upon other crops. The principle climatic obstacles in the dry region consist not alone in the absolutely small quantities of precipitation during the year, but even more in the irregular and capricious distribution during the period of plant growth. For instance, the rain often falls after rye and wheat have completed their growth, and thus is useless. Not only are these rains useless to these crops, but also to crops in general, since there are no crops grown by most farmers which could utilize the precipitation at this time of year. The experiment stations, in studying the various cultivated plants of the dry regions, discovered a number of crops which, after being planted in the spring, grow all summer and mature in the fall, thus utilizing the late rains. These plants are usually planted with a wide space of land between the rows, which, during the summer, are frequently cultivated to destroy the weeds; consequently they are called "cultivated" or "row" crops. This group of plants is quite diversified, but are similar in having a long period of growth, and in being able to utilize the rains which usually occur in sufficient quantities during spring, summer, and the first half of autumn.

For example, let us take proso-millet or corn. These crops, planted in the last days of April or early in May, grow very slowly, as they require a considerable amount of heat for their development. As these plants develop slowly at the beginning, they are not greatly injured by early spring drought, and utilize to good advantage the moisture and warmth of the soil. As was noted previously, the drought is commonly broken by rains in June or July. Proso-sorghum and corn utilize these summer rains for their rapid development and continued growth. Corn can even utilize the August rain

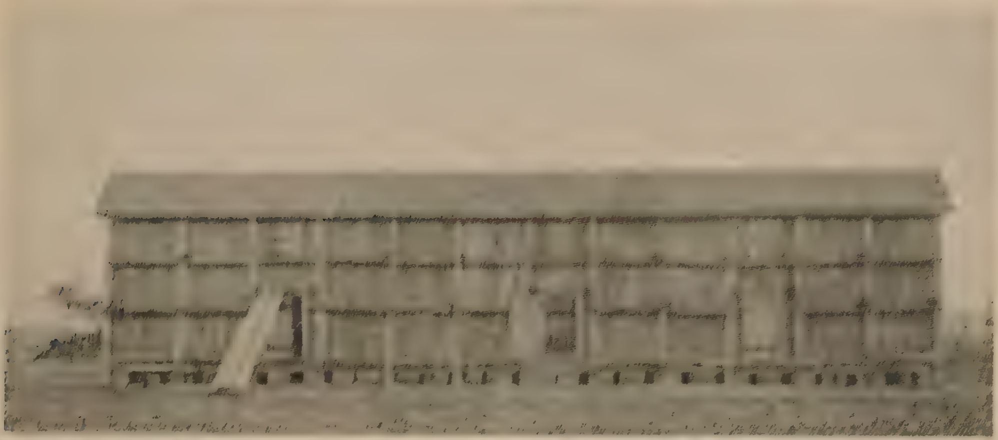

FIGURE 23.—A typical corn crib in the sections where maize can be grown advantageously as a grain crop.

which as a rule can be depended upon. The yield of corn in the Volga Region Experiment Station varies from 18.5 to 22.5 quintals per hectare, and is sometimes even higher, but the yields of the proso-millet usually average only 15 quintals per hectare. The importance of these "row" or intertilled crops to the agriculture of the Volga area is illustrated by crop yields during recent years, particularly in 1924. With an almost complete failure of spring grain on the adjoining peasant fields during that year, the crop of proso-millet on the field of the Saratov Experiment Station yielded 16.5 quintals per hectare, and the yield of corn was 15 quintals.

There are other crops of promise. A little smaller yield is produced by sunflowers, which also have a long vegetation period, but the yield frequently depends on other causes than the weather. However, the sunflower is well adapted to this region. A whole series of cultivated root crops, mangles, carrots, potatoes, etc., and vine crops, such as pumpkins, watermelons, and cantaloupes, have the same long-season growth characteristics, as do corn and proso-millet. They can utilize the summer rains and heat and do not suffer much from spring drought. Some difficulty arises, however, in obtaining strong germination of mangles and watermelons, if the spring is too dry, but this is not an unsurmountable difficulty and does not prevent the growing of these crops.

As regards forage crops, the experiment stations in the Volga Region paid considerable attention to both perennials and annuals, to those which provide succulent feed during the summer and to those that provide hay during the winter. Investigations were carried on with alfalfa, brome grass, and many other perennial grasses, notably the sorghums, sudan grass (recently), mogar, corn as fodder and as ensilage, winter rye for fodder, and various mixtures of vetches. The main object of investigation was to find such plants as would utilize the precipitation of the entire vegetation period. This was found to be best achieved by a combination of perennial and annual forage plants. The results thus far

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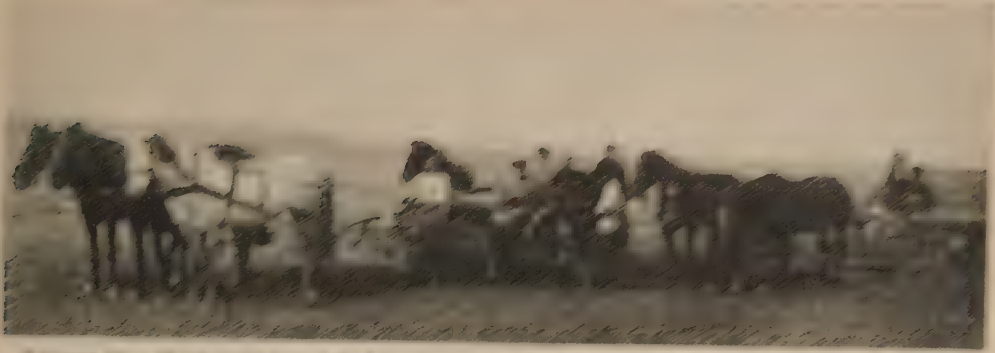

FIGURE 15.—Machinery is rapidly being introduced on a large scale into the dry farming operations of the dry regions. [illegible]

variety of seed-producing sunflowers resistant against some of the most important enemies of the crop in this region. Excellent work in selection also has been done with perennial forage crops, particularly yellow-flowered alfalfa and Agropyron (Triticum) cristatum. This work has furnished the growers of the dry Volga area with good yielding forage crops of high quality.

BETTER ORGANIZATION OF AGRICULTURE

The information in possession of the experiment stations on methods of cultivation of various crops enables them to outline definite plans of agricultural organization which will correspond to the natural conditions of this region and permit maximum utilization, particularly of precipitation.

The Volga area is so large and natural conditions so diverse that it is impossible to outline one common system of farm organization which would be applicable to the entire area. In the extreme eastern and southern part just outside of the isohyet of 250 millimeters of annual precipitation, crop production cannot play an important part because of the deficient rainfall, and stock-raising in its various forms will have to remain for a long time the principal occupation of the inhabitants. For this kind of agriculture it is necessary to have a supply of winter fodder, without which the stock often perish, and this requirement of the stock men must be taken into consideration in organizing the agricultural system. The supply of fodder must be provided by growing fodder crops on a large scale in the more suitable lands or by utilization of the meadows, sometimes improving them by artificial irrigation. These are questions that will have to be decided locally, but even for this section of the Dry Region the methods of improving the fodder yields have been sufficiently demonstrated to furnish the local agricultural adviser with basic information. In other parts of the region grain growing will remain the main industry of the population, but with it must be developed stock-raising, not in such primitive forms as are used in the Kazakstan and Siberia, but in more complex forms, involving closer correlation between grain growing and stock-raising.

It has been pointed out that the great variations among the cultivated

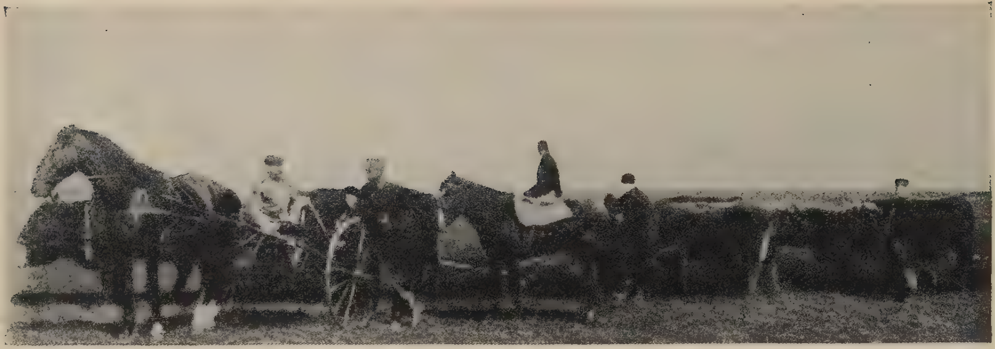

FIGURE 27.—Both oxen and horses are utilized as draft animals, both having their advantages and disadvantages.

plants in their utilization of warmth and moisture at various times of the vegetation periods make it possible and even necessary to raise such crops as will grow during a long period and utilize for their development the warmth and moisture of the second half of the summer. Such plants are found mostly among the fodder plants, but there are also several in the group of so-called "industrial" plants. The farmer should, therefore, grow a variety of crops, and for the proper utilization of the fodder crops the farmer must include a system of stock-raising. The stock should be fed not only on the natural pastures, but also on the crops which are harvested from the fields.

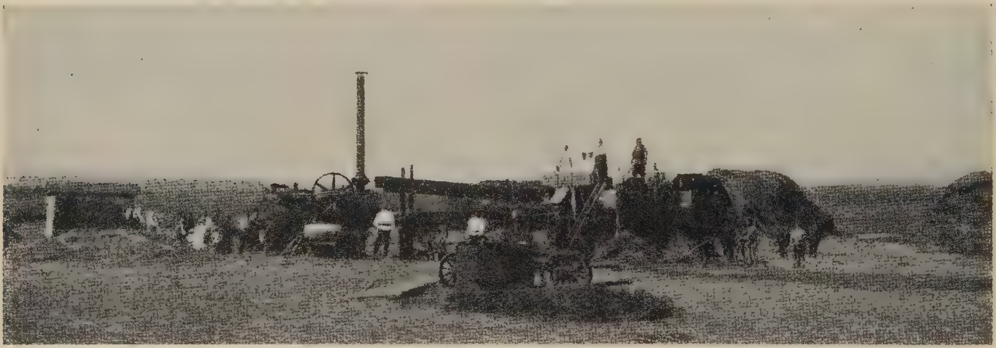

FIGURE 28.—Threshing in the field with modern machinery, an outfit not unlike those of the great grain empires of the American Northwest and Canada.

To combine the growing of field crops with stock-raising it will be necessary to work out in detail systems of farm organization for various sections of the region. It may be found, of course, that in some sections of the Volga area the main income of the farm will be the selling of hard wheat, and livestock will be kept on the dry fodder from the wheat fields and on the native perennial grasses. The livestock will provide sustenance for the farmer and will act as insurance against the years when the yields of grain crops are very low. In other sections there is hope of establishing a great variety of crops, particularly cultivated crops such as roots, potatoes, corn, sorghum, and other products

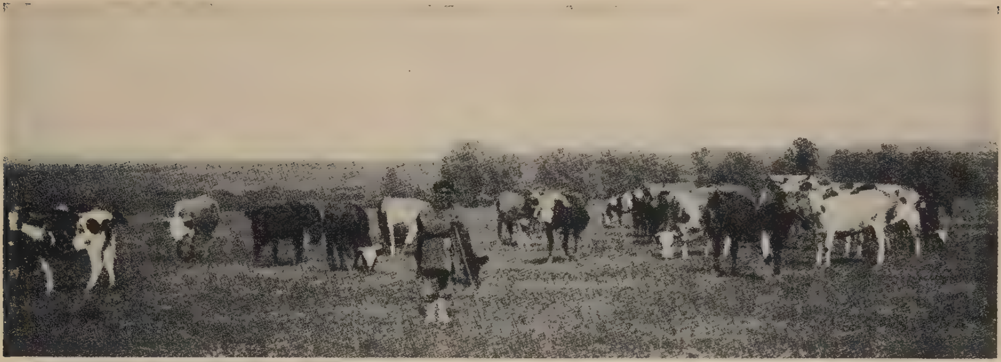

FIGURE 29.—Cattle form one of the dependable features of the dry-farming landscapes, for grazing on the lands least adapted to cropping must supplement the dry-farming economy.

which can be used for silos. The growing of perennial fodder crops may not prove profitable here owing to the lack of land, but in place of them the annual fodder plants can be grown. The latter give an opportunity to establish a better and more suitable crop rotation; and, on the whole, will produce fully as good quality of crops as the perennial plants.

The systems of stock-raising in these sections will be different. While in the sections with dry fodder it is natural to raise beef cattle and only occasionally dairy cattle, in the section where the root crops and green fodders are raised it may be expected that the development will be toward dairying and also hog-raising.

In other parts of the lower Volga area, the program of crop diversification will be directed toward industrial crops, such as sunflowers, potatoes, and, in some places, sugar beets, together with forage crops grown in rows. The growing of industrial crops should play an important part in the local agriculture. The correct methods of growing industrial crops have a great influence upon the organization of agriculture, and constitute one of the most important factors in its prosperity. As the processing of these industrial crops is usually done within the province where the products are grown, the by-products from these crops, cakes, meals, and pulps, can be utilized on the local farms, and thus increase the supply of fodder.

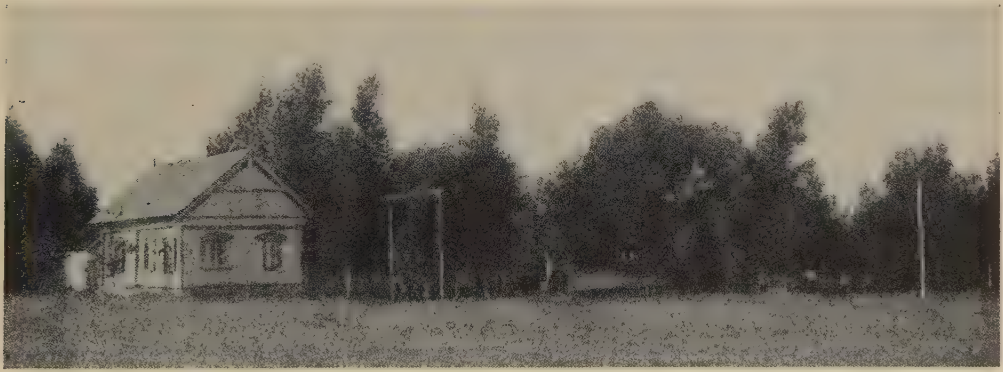

FIGURE 30.—A typical scene in the dry-farming regions where by careful choice of site and attention to growth a hospitable grove shelters the buildings.

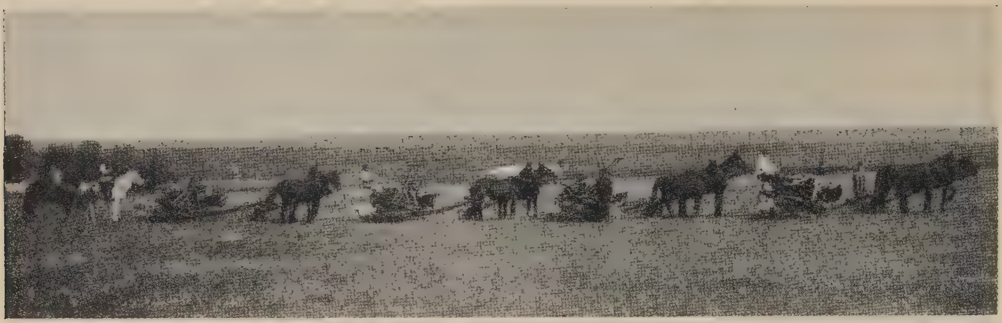

FIGURE 31.—Grain binders on the way to the harvest, showing how modern machinery is invading the steppe agriculture and extending the crop-growing areas.

STOCK RAISING

Sufficient data are at hand to warrant the assertion that stock-raising in the dry region should receive most serious attention, and especially the relation between field crops and livestock should be worked out definitely and in detail.

From the standpoint of the local agricultural organizer, the advantages of the region in livestock production are notable: (1) The forage crops are very suitable for stock-raising and the great extent of steppes provides vast pasturage. (2) Although the vegetation is often parched by the summer's heat, the quality is excellent, and the summer rains usually cause the vegetation to revive rapidly and supply green pastures during the fall months. (3) In the eastern part of the far Volga area, there are numerous natural meadows, at times covered with water, which could supply enormous quantities of hay with a comparatively small expenditure of labor for its preparation.

Organization of the production of livestock on a large scale for meat on the steppes of the far Volga area will be possible only when proper facilities are provided for the handling and shipping of meat products to large cities in the Union, and also for export. It will be necessary to have an adequate system of transportation, not primarily for the transportation of livestock, as was done before the war, but of the products of the slaughter houses located where the cattle are raised and fed. In order to accomplish this, it will be necessary to build suitable slaughter houses, refrigerators, packing and canning establishments, also make provision for complete utilization of all by-products—in brief, create such an organization for the industry as will assure maximum utilization of the stock where it is raised.

Conditions in the Dry Region are particularly well adapted to horse breeding, which was quite extensively practiced there in the past. Cavalry horses of the Don and Ural Provinces were the natural products of the steppes, and there is no reason to suppose that this type of animal will not be reëstablished in the near future.

At the present time, the demand for dairy products is developing rapidly, and to satisfy this demand dairy farming is increasing, particularly in the vicinity of large cities.

Closely related with dairying is swine culture which has possibilities for development in the future. The development of these two branches of animal husbandry is favored by the abundance of bran and cake in this area. The existence of large flour mills and oil pressing establishments afford the farmers an opportunity to secure comparatively cheap concentrated feeds, which are used to such advantage by these two types of animals.

FIGURE 32.—Shorthorn-Kalmitzki ox, three years old, a variety used both for draft and beef.

RÔLE OF LAND SETTLEMENT

In order to reorganize agriculture in the region, it is first necessary to have sufficient land suitable for settlement. The possibility of improving the methods of cultivation, of introducing new crops for stabilizing agriculture, of reclaiming larger or smaller areas of land—all these are only possible when the settlers, whether as individuals or groups (collectives) have every opportunity to experiment with new methods.

The very large villages (congregated farm settlements) of the Volga area, which were formed partly on account of lack of water in the steppes, and partly on account of peculiarities of the population in the distant past, have large areas of land available for cropping. The peasants waste a lot of valuable time going to and from the fields and barns during the planting and harvesting season.

The distance of the fields from the homes of the peasants is the peculiar characteristic of the Volga area. In the more thickly settled sections, the land is subdivided into small fields (in order that the various types of lands should be equally divided among the peasants). Both these circumstances interfere with the correct organization of field husbandry. A very important interest of the agronomists is this problem of land subdivision.

The various forms of land settlement have developed out of actual experience and depend on natural conditions of the locality and social environments. In the Dry Region the most important part of all the work of reorganizing agriculture will be the bringing of the population closer to the land which it works, and in many localities the question of proper water supply also is important. In fact, the problem of water supply usually takes the front rank in all projects for land settlement and subdivision in the Volga area.

AMELIORATION OF CONDITIONS

Immense areas of the lower Volga area have been divided into amelioration districts, in which nature itself, as well as the agricultural conditions, point toward entirely different possibilities of amelioration. In a very large portion of the lower Volga area, the water supply is so limited that amelioration by irrigation becomes insignificant, but a considerable extent of land may be ameliorated through the utilization of spring precipitation on the natural meadows. A small portion of this ameliorated land may be utilized for the growing of spring grains.

In the section with a small amount of precipitation (about 300 millimeters a year) where yields of grain crops under the usual field tillage are uncertain, there is a possibility of constructing water reservoirs. These irrigated lands could be utilized for garden and orchard crops for home consumption. However, according to the conclusions of irrigation experts, such amelioration measures in the lower Volga cannot become important except as they influence the permanency of agriculture.

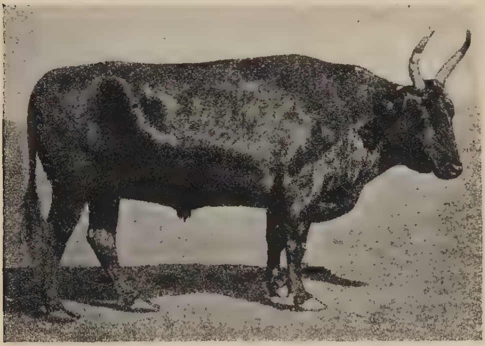

Figure 33.—Kalmitzki ox, seven years old, illustrating the sturdy, well-developed type widely distributed over the steppes.

Necessarily the main form of agriculture in the vast extent of the Volga area will be dry farming, at least for many years; but the organization of agriculture in which proper attention will be given to the correlation between field crops and animal husbandry will, in due time, bring irrigation in those places where it is possible and profitable. Such irrigation may lead to the development of other branches of agriculture, which will in the end strengthen the whole system of organization and enhance the prosperity of the farmers.

While speaking of amelioration possibilities in this area, the so-called "snow amelioration," that is, the utilization of the snow which is usually blown off during the winter into ditches, villages, and other obstacles in the steppes by the constant winds, must not be ignored. Notwithstanding the meagreness of the snow covering, the proper utilization of the moisture in the snow would be of greatest benefit in crop production.

CONCLUSION

The natural and agricultural conditions of the dry Volga area are very similiar to the conditions of the dry areas in other parts of the Union of Soviet Republics, and schemes of agricultural organization in these various dry sections can be adopted as soon as these schemes are successfully worked out in a part of the Volga area, where conditions are similar. It is, of course, impossible to transfer mechanically the plan and organization of the agriculture of the individual parts of the Volga area to other sections. It will be necessary to make a preliminary comparison in detail, of the natural conditions, the perspective of agriculture, and the economic situation in every individual case. In particular, there is reason to believe that the reorganization of agriculture in the Volga area will serve as an example in planning new, more perfected forms of agriculture for extensive areas in the Asiatic portion of Soviet Union. The plans purpose to achieve full coördination with the natural conditions and with the demands of the rapidly developing peasant farming. The aim is to utilize fully the natural resources of the region for the increase of the prosperity of its inhabitants.

THE GERMAN SUGAR BEET INDUSTRY

E. Muriel Poggi

Geographer, University of Illinois

THE world's sugar supply was drawn chiefly from the cane-growing countries of the tropics until the middle of the last century. No special interest was attached to the sugar beet till the publication, in 1747, of Marggraf's pamphlet in which he set forth his discovery that the beet contained sugar. In 1799 Archard, a pupil of Marggraf, presented the king of Prussia with a few pounds of sugar which he had produced from beets, with the result that in 1801 the king financed, for him, the erection of a small factory in Silesia, the first beet sugar factory in the world. It was to Napoleon, however, that the development of the beet sugar industry was largely due. During the European wars of 1800–1815 there was a great shortage of sugar in Western Europe owing to the embargo on the West Indian product. Napoleon offered the first government bounty on beet sugar in 1806; in 1811 he issued a decree to put 79,000 acres of French land into beet cultivation and started the industry off on large-scale operation.

The production of beet sugar increased so that its proportion of the world's sugar crop rose from 14 per cent in 1853 to 65 per cent in 1900. In 1853 the beet sugar production was only 202,000 tons as against 1,260,000 tons of cane sugar. At the beginning of the World War the production of sugar beet was 8,908,000 and the cane production 9,879,000 tons.[1]

Early in its history beet sugar became an important rival of the cane product. The race between the luxuriant perennial cane of the tropics and the carefully cultivated beet of the middle latitudes has been an interesting contest during the past 80 years (see Fig. 1). The leading place was won by beet sugar in 1883. Occasionally after this cane sugar forged ahead but did not hold the lead before the World War. The chief European governments used bounties, drawbacks on exports, and other measures to encourage the producers of beet sugar and thus enabled it to supersede cane sugar in Britain—the largest import market. The effect on the West Indian industry was disastrous. Finally, the principal Western European governments agreed, under the terms of the Brussels Convention of 1902, to do away with the artificial aids to beet production and the industry was forced to "stand alone." Figure 1 shows the trend of sugar production. Beet sugar, stimulated by bounties and tariffs, was approximately equal to cane production from 1884 to 1914. Since 1914 cane sugar has continued to increase while beet declined in relative importance to less than one-third of the total sugar supply of the world in 1922. It

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[1] Schneider, F., "Sugar." *Foreign Affairs*, Vol. 4, No. 2, Jan., 1926, p. 313.

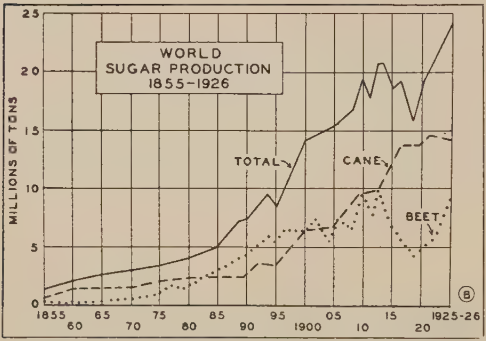

FIGURE 1.—The production of cane and beet sugar was about equal in 1913; then the beet production dropped and continued to do so until 1918. During the war the cane production increased steadily. It was not until 1927 that the cane and beet curve began to approach each other again. (Figures from Yearbook, U. S. D. A., 1923, and International Crop Report, Rome, 1926.)

must be remembered that the countries that grew sugar cane were affected least by the War and their production progressed unhampered. The countries producing beet sugar were so located as to suffer severely under war conditions, especially the three chief exporting countries—Germany, Russia, and Austria-Hungary. This is clearly shown by the following figures showing their beet sugar output for two significant years:[2] 8,750,000 tons in 1914 and 3,610,000 tons in 1918.

About 1919 the production of beet sugar began to increase substantially (Fig. 1) and the figures for 1925–1926 show that the industry is nearly at its pre-war level. The economies of large-scale production of cane sugar by American Corporations in the West Indies, however, will force beet sugar interests in Europe to the highest efficiency of production if they are to compete in the export field with cane sugar.

Since 1899 the output of cane sugar has steadily increased. The same cannot be said of beet sugar. If the merchant realizes that the available quantity of cane sugar is certain whereas that of beet sugar is uncertain, there is no doubt as to which of the two he will handle. The question, "Why is there a difference in the degree of certainty?" follows, naturally. The answer is a serious one for Germany. That both of these varieties are influenced by their climatic environment is certain. It is true that the sugar beet possesses a remarkable adaptability to various climates and soils; nevertheless, a world map showing the distribution of the crop presents evidence that climate still controls. This is Germany's largest handicap in its problem of beet cultivation. Cane sugar grows where labor is cheaper than in Germany. Its cultivation demands less attention and harvesting is a simpler and easier process than is the case with beets. In Germany the area possible for the spread of the sugar beet is limited. At present it is about as extensive as possible. The tropics are only beginning to be penetrated. Sugar cane has only been cultivated systematically for a few years; that the output of the latter is likely to sur-

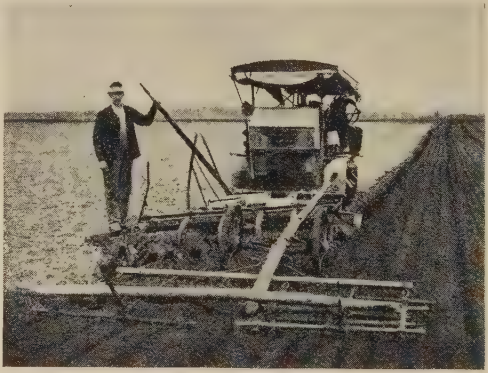

FIGURE 2.—Steam plough and harrow on the beet field.

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[2] Simpich, F., *Commerce Reports.* Vol. 23, April 17, 1920, p. 339.

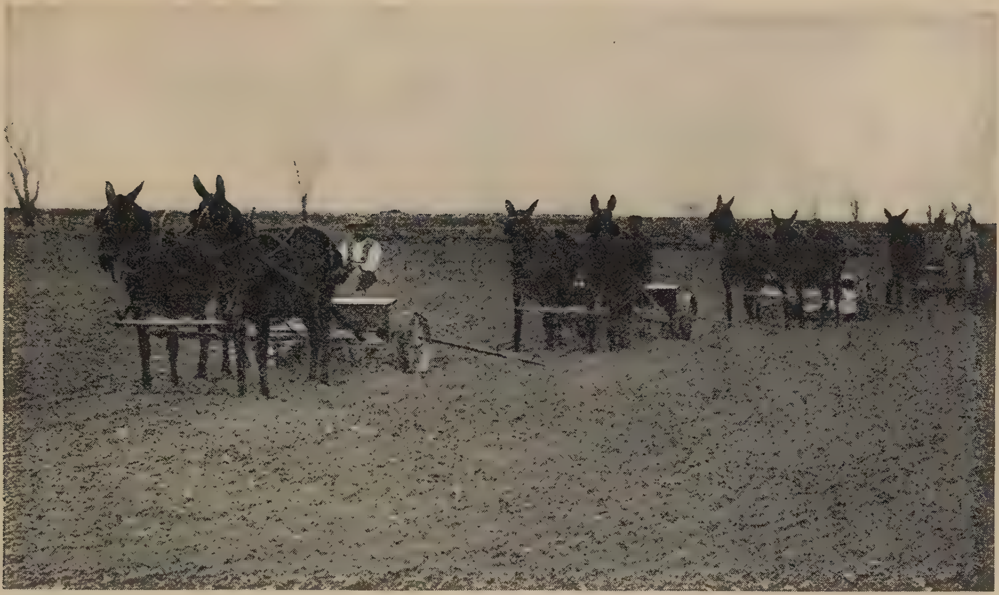

FIGURE 3.—Drilling machine, horse- or mule-drawn except on the largest plantations where motor drills are the rule.

pass that of the sugar beet is quite possible if not probable.

The sugar beet is a native of Europe. It requires, for its best development, moist and fairly mild conditions with much sunshine for its vegetative period and a dry sunny autumn. Cooler weather is said to be best for the maturing season. Because of the necessity of a constant moisture supply during the growing period, soils of heavier texture are desirable. These conditions are found throughout Northern Europe from Northern France to Central Russia. Early in the history of the industry beets became an important crop in central Germany and Bohemia. Various reasons may be put forward for the success of the industry in these countries, among them, the German interest in chemical industries, the comparatively cheap labor supply and the fact that there is little room for pasturage and the people find it profitable to feed their cattle on the pulp that is left after the sugar has been extracted from the beets. The industry has developed in areas in Germany where the population is dense and where, accordingly, the market is close at hand; where, too, manure is abundant or the advanced state of commerce renders it easily procurable.

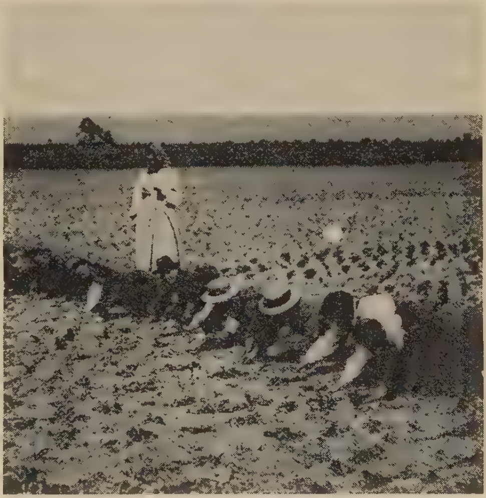

FIGURE 4.—Thinning out the young beets. This work is done almost entirely by hand.

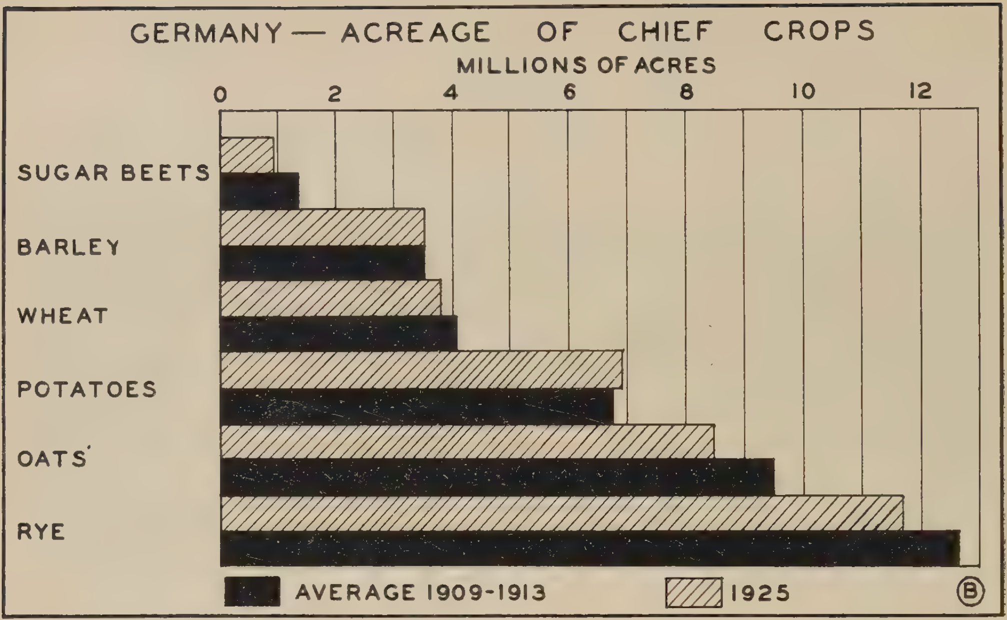

FIGURE 5.—The sugar beet is an intensive crop, hence the small acreage. Although there was a large surplus of sugar for export in 1913, the best occupied less than one-half the acreage of any other German food crop. (Based upon International Crop Reports and "World's Food Resources" by J. R. Smith.)

Capital is plentiful and consequently the low rate of interest on money favors the erection of the best machinery in the factories. The advantage of yielding a refuse material which is a useful manure (in adding

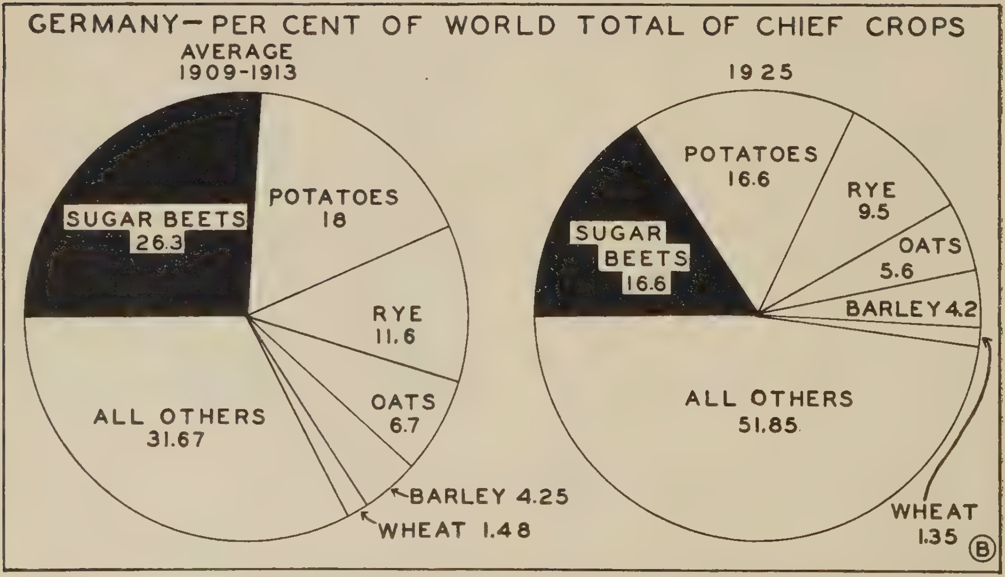

FIGURE 6.—In 1913 Germany produced more than one-fourth of the world's supply of sugar beet; this dropped to practically nothing during the four years, 1914–1918, but by 1925 she was supplying approximately one-sixth of the world total of beets. (Figures supplied by Bureau of Agr. Economics, Washington, D. C.)

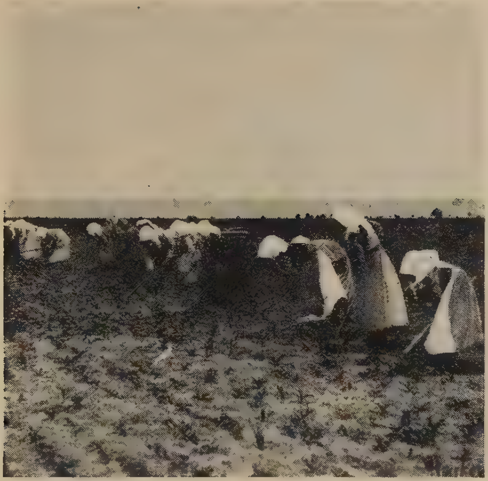

FIGURE 7.—Hoeing between the young plants. Gangs of women frequently do this work, supervised by one man.

potash to the ground) and a valuable food for cattle is of special importance in thickly peopled countries. The mention of these conditions affecting the cultivation of the sugar beets enables one to understand why the plant cannot be cultivated with success in all parts of the world in which the climate is suitable.

To Germany is due a major part of the credit for the scientific studies by which the sugar-yielding qualities of the beet have been raised from 1 pound of sugar in 18 pounds of beets to 1 pound in about 6 of beets.

The beet acreage of the world is surprisingly small. With her large sugar export before the war (1,126,217 metric tons),[3] Germany raised her whole crop on but 1⅓ million acres of ground, 2,000 square miles, less than 1 per cent of her total area (Fig. 5).

These figures accentuate the fact that the sugar beet is essentially an intensive crop, which is another reason why central Germany, with its dense population, access to large supplies of chemical fertilizers, and easy and cheap means of transport, should be especially suited for this crop.

The development of German agriculture during the last 40 years presents a striking illustration of what may be accomplished in a country whose cultivable area is sharply limited by natural conditions and whose expansion in production has been possible only by intensive cultural methods, the scientific use of fertilizers, and the closest attention to seed breeding.

The sugar beet ranks with the five most important crops of Germany —rye, oats, potatoes, wheat, and barley. Though the acreage under sugar beet is relatively small, its importance may be seen by consulting Figs. 5 and 6, which show the acreage under the six chief crops of Germany in pre- and post-war years and the per cent which the German production of these crops forms of the world total of each. From Figs. 5 and 6 it can be seen that although the sugar beet acreage was much smaller than that of the other important crops before the war (1909–1913), the German production represented 26.3 per cent of the world total of sugar beet, a much higher per cent than that of any other German crop. Fig. 6 shows that in 1925 the acreage has decreased, due somewhat to territorial changes, and the per cent of the world crop of the German sugar beet is only 16.6 per cent, but even then none of her other crops have a higher per cent of the world total, potatoes being the same as sugar beet and rye next, representing 9.5 per cent of the total world production.

There is a certain amount of interesting coöperation possible between the cereal farmers and the beet producers. Oats and barley are almost entirely spring-sown and this usually occurs before beet and potato planting. These two crops are planted almost simultaneously. Potatoes, at the time of planting, make greater demands than beets upon the labor supply, because of the cutting of the seed potatoes. The preparation of the beet seed bed, on the other hand, involves much more work than that of the potato seed bed. Once the crops are above ground, beets require many times more work than do potatoes, much of which is hand work. Cultivation of potatoes ends long before the painstaking hoeing and weeding of beets ceases. Potato harvest is usually complete before the beet campaign opens. Crops of oats, barley, and the fall-sown wheat and rye require no labor from the time of planting to the time of harvesting, and their harvest is past when the labor supply is needed for the beet campaign.

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[3] Supt. to Com. Reports, *Trade & Econ. Rev.*, 1922, Germany, p. 3.

The beet sugar industry of Germany is confined chiefly to Saxony, Brandenburg, Silesia, Hanover, Pomerania, and the Rhine Provinces, though other provinces of central Germany are also producers as will be seen from Fig. 8. The cities of Magdeburg, Hanover, and Breslau are the chief centers of the industry; this is also brought out by Fig. 8, as the areas of heaviest production are seen to be around these towns. These three cities have the largest number of sugar factories: Magdeburg 90, Hanover 63, Breslau 34.[4] Delitsch, ten miles north of Leipzig, is also an important center and a large seed-breeding station.

A glance at the physical map suggests at once the reasons why these towns early became important for beet sugar. Each is on or near one of the great inland waterways of Germany—Magdeburg on the Elbe, Breslau on the Oder, and Hanover on a tributary (the Leine) of the Weser. Each has long been the nucleus of a densely populated area. Hence, there was in each case a large market for the product in the neighborhood, and easy and cheap means of transport for the surplus to be carried to the seaports for export.

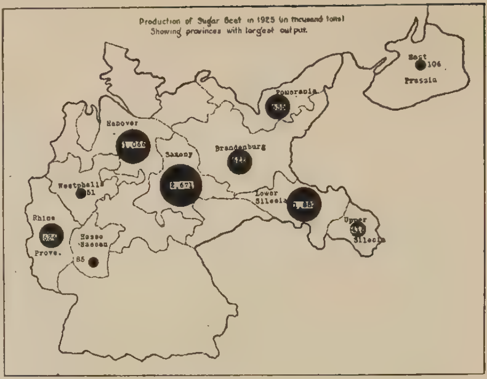

FIGURE 8.—Saxony, Hanover, and Silesia are the chief beet-producing provinces. In addition to the necessary physical conditions, a relatively dense population accounts for adequate labor supply and markets for the sugar. (*Statistisches Jahr Buch, 1926.*)

Among the factors which influence the cultivation of the sugar beet, the environmental conditions of soil and climate are of major importance. The German portion of the European plain is only slightly above sea level, with occasional minor variations, remains of ancient moraines (most of central Germany having been heavily glaciated). The soil is chiefly of medium or light sand, excellent for rye or potatoes. In some districts a good loam prevails and in the river valleys a medium to heavy alluvial soil predominates. In the sandy soil of the plains, rye is the principal grain crop and potatoes the chief hoed crop, the richer loams being reserved for the sugar beet. When considering the most suitable soils for this crop, Knauer, one of the great German authorities on sugar beet, says: "A loess soil with a smooth surface, slightly inclined to the south, as little stony as possible, rich in humus and very deep, on a subsoil, water-filled and non-pebbly, present the best conditions."[5]

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[4] Agricultural Survey of Germany, *U. S. D. A. Bull.*, 1399. May, 1926.

In the sugar beet fields, the productivity of the soil is maintained by the application of artificial fertilizers, by the use of barn manure and by crop rotation. The sugar beet is not so exhaustive to the soil as corn, wheat, and tobacco, but more so than potatoes, beans, and grasses. Beets, being heavy consumers of nitrogen, potash, and lime, naturally respond profitably to the application of these fertilizers, which not only increase the tonnage of the beets but also the per cent of the sugar. The highest tonnage yields have been obtained by the generous application of stable manure, but the crop in each case gave a lower per cent of sugar than was realized from land treated with commercial fertilizers, bearing the above-named constituents, and a lower per cent than was obtained from plots having no fertilizer application. Since the beet crop requires an abundance of lime as one of its plant foods, a calcareous loam of strong clay admixture seems best adapted from the standpoint of plant foods and fulfills the physical requirements.

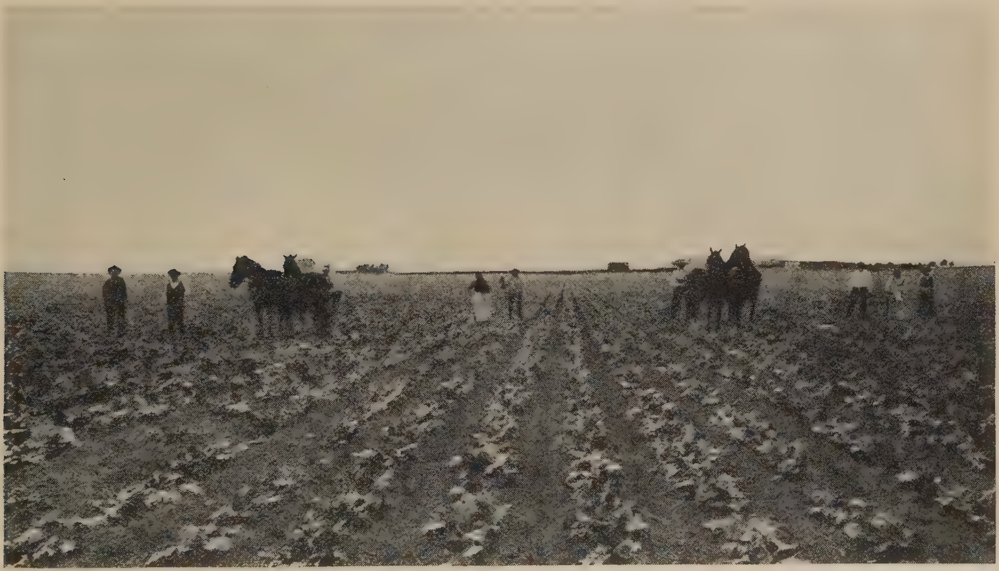

Figure 9.—On many large estates in the Magdeburg district, hoeing is carried on by horse-drawn machines.

The European beet farms are almost always well cared for because the beet manufacturing companies, to assure themselves of a good supply of beets, insist, in their contracts with the grower, that a certain rotation of crops shall be followed. Furthermore, the care and fertilizing required by the beet, leaves the field in excellent condition for the production of small grain. This rotation results

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[5] Knauer, F. "Der Rubenbaum," 1906, *Bull. Amer. Geog.*, Vol. 47, p. 248.

Figure 10.—Beet field before the harvest.

in such increased yields of grain per acre that it is said that the addition of beets to the crop rotation has not reduced the total grain of the beet districts.

Different crop rotation is practiced in different localities. In Upper Silesia, for instance, where the soil is rather heavy, No. 3, shown in the table below, works best. In more sandy regions, No. 2 gives the best results.

Table 1

Crop Rotations Used in Sugar Beet Culture *

1	*2*	*3*
Sugar beets,	Sugar beets or	Sugar beets,
potatoes,	potatoes,	barley,
oats,	barley or oats,	rye,
barley,	sugar beets or	red clover,
rye (winter),	potatoes,	sugar beets,
wheat,	potatoes,	barley or oats,
sugar beets.	barley or oats,	cereals (in variety),
	clover,	sugar beets.
	sugar beets.	

* Van Cleef, E., *Bull. Amer. Geog. Soc.*, Vol. 47, p. 249.

In considering climatic conditions, as far as temperature is concerned, experiments have indicated that beets attain their greatest perfection in a zone of varying width, through the middle of which passes the isotherm of 70° F. Beets require a long day with plenty of sunshine during the growing season. Abundant moisture is needed in the early stages of growth to insure roots of good size, and this should be followed by a period of less rain, more sunshine and cool nights for the development and storage of sugar.

In Europe the sugar beet is usually sown in April and harvested in September. Planting takes place as soon as the ground is free from frost. One kilogram (2.2 lbs.) of seed should produce about 70,000 plants in rows 14 inches apart, and plants 10 inches apart in each row. Though it is sown to the depth of only 2.3 centimetres, the soil must be deep. There is practically no time between the day of planting and that of harvesting when the sugar beet needs no attention. Just as soon as the plant appears above ground the work of cultivation begins. In order to produce the largest yield of beets, intensive culture is essential. Much of the work can be done by machinery, but the early cultivation and thinning must be done by hand and with the hoe. The German peasants have the idea that they hoe sugar into the beets, and this is not far from the truth, since on the same quality soil the sugar content varies from 10 to 18 per cent depending on the method of cultivation. At harvest time the soil is loosened around the roots by running suitable ploughs along the rows, after which the roots can be "lifted" or "pulled" by hand. After lifting, the crowns and attached leaves are cut off and the roots sent to the factory. Here they pass through mechanical "washers" which remove all adhering soil and stones and the clean roots pass to the weighing machine. The beet grower is paid on a basis of this "true" or "net" weight, which is very much less than the gross weight transported from the field to the factory. The tonnage of clean roots per acre varies considerably in different countries, according to the variety of beet cultivated and also in any one country in different years according to the rainfall. The following figures show the tonnage per acre in the chief sugar beet-producing countries of Europe in 1913.[6]

TABLE 2

Country	*Tons per Acre*
Germany	14.2
France	10.6
Belgium	11.8
Czecho-Slovakia	12.7 (1914)
Russia	6.0

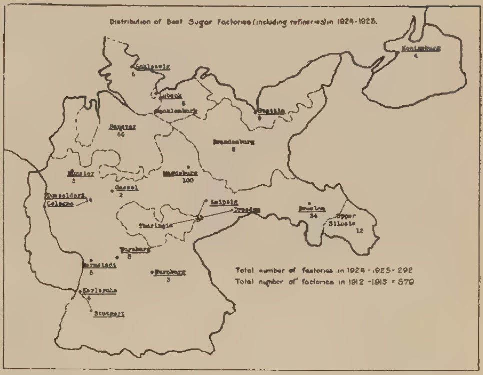
Distribution of Beet Sugar Factories (including refineries) in 1924-1925.
Koenigsberg
4
Schleswig
6
Lubeck
5
Mecklenburg
Stettin
9
Hanover
66
Brandenburg
9
Munster
3
Magdeburg
100
Cassel
2
Dusseldorf
Cologne
14
Leipzig
Dresden
Breslau
34
Upper
Silesia
13
Thuringia
Wurzburg
8
Darmstadt
5
Bamberg
3
Karlsruhe
4
Stutgart
Total number of factories in 1924-1925 - 292
Total number of factories in 1912-1913 = 379

FIGURE 11.—Magdeburg, Hanover, and Breslau have the largest number of factories. Each of these cities is on or near a great waterway, and each is the center of a densely populated industrial area. (Figures supplied by U. S. Bureau of Agr. Economics.)

Upwards of 100,000 people are permanently employed in the sugar beet industry in Germany. These laborers are primarily women, girls, and children—family labor. The thinning of the beets as well as its cultivation is done largely by women. Their wages are about 60 per cent that of men. It is estimated that the labor needed to produce an acre of beets is about 10 times that required for an acre of wheat. Many "season" workers or immigrant laborers are brought to the work from Russia, Hungary, and Poland. This seasonal migration of labor was at first a small one from the east, to take care of Saxony's sugar beet crop—the term "Saxon Ganger" is an old one. Such labor was not imported only into Saxony, but it also reached the Central and Northeast territory. As many as 400,000 Poles yearly migrated to Germany before the war. They returned to Poland after the harvest; in fact, by law, these immigrants must be returned to their own countries by November 15. With regard to the present labor supply, the sugar factory industry is beginning to "dovetail" into the beet-growing industry and this should be the means of maintaining the resident labor supply in the sugar beet areas all the year round. The factory industry is essentially a seasonal one, being carried on only for three or four months, during the winter, after the beets are harvested. It accordingly will provide employment in country districts at a period when agricultural employment is slack.

The distribution of factories, including refineries, in Germany in the season 1924–1925 is shown in Fig. 11, the total number being 292, whereas in 1913 there were 379. In some instances the falling-off is due to territorial changes made by the Treaty of Versailles; some 30 factories were lost in this way, 10 in East and West Prussia, 19 in Posen, and 1 in Alsace Lorraine. In some cases factories were closed down during the war and have not since been opened, but as the acreage under sugar beets is now steadily increasing, no doubt more factories will resume work each year.

The sugar factories are located as centrally as possible among the fields. Competition of the finished product with cane sugar demands this; beet sugar must be sold at least as cheaply as cane sugar. Most of the

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[6] *U. S. D. A. Bull.* No. 987, Handbook of Foreign Agricultural Statistics.

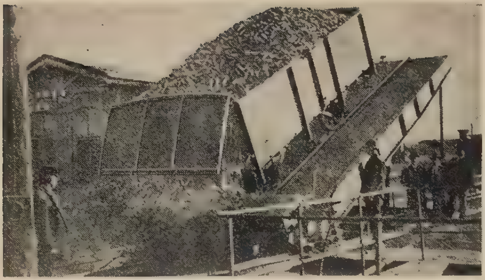

FIGURE 12.—Electrically-driven tilting car dumping beets into the washing machine whence they are carried when clean to the slicer.

beets are received from the fields without cost to the factory. The manufacturers, in most cases, supply the seed free of charge in the spring and therefore can demand free delivery in the fall, under these conditions.

In the manufacture of beet sugar, the beets delivered from the storage sheds, after being thoroughly washed, are cut into thin slices or chips. These are then conveyed to a diffusion battery where the sugar is removed from the chips by water at about 85° C., into which the sugar diffuses. The exhausted chips are pressed, dried by heat, and used as a cattle food. The diffusion juice, containing from 12 to 15 per cent of sugar, is treated with excess of lime to purify it, and the dissolved lime is precipitated by carbon dioxide, after the removal of which, the operations of liming, carbonization, and filtering are repeated. The juice is then evaporated, crystallized, and centrifuged, as in making sugar from cane juice. The raw beet sugar is not suitable for food until it is refined.

In figuring the cost of production, the by-products, all of which are valuable, must be counted as one of the assets to the industry. After extracting the sugar, the farmer can feed the residue from the mill to his livestock. The pulp is either transferred to large silos for winter feeding, piled green in bulk in the field, or dried for mixing and shipment. The best results have been obtained by partially drying and mixing it with such feeds as molasses, oil cake, ground grain, or chopped hay. In Germany more than one-half the total pulp output is dried, for use in the manufacture of mixed stock feeds. In the artificial drying the amount of water is reduced to about 10 or 12 per cent (from 90 per cent) which represents the average content of water or moisture in hay. The product at this stage resembles green tea in appearance. The drying is for the purpose of decreasing the weight and bulk and to prevent the deterioration of the product from fermentation. The Germans utilize beet pulp, to a limited extent, in the manufacture of paper.

Molasses is an important by-product; it is the liquor from which the sugar crystals have been separated. It is also an important source of alcohol. Vinasse or Spent-wash is obtained from molasses by distillation, after separation of the alcohol, and contains the whole of the potash and part of the nitrogen present in the original molasses. It is largely

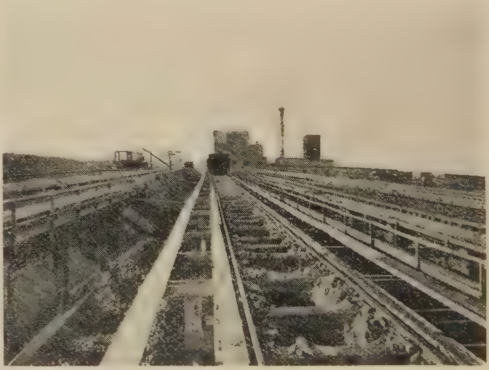

FIGURE 13.—At some factories the beets unloaded on the railroad are transported to the washer by moving belts below the ties.

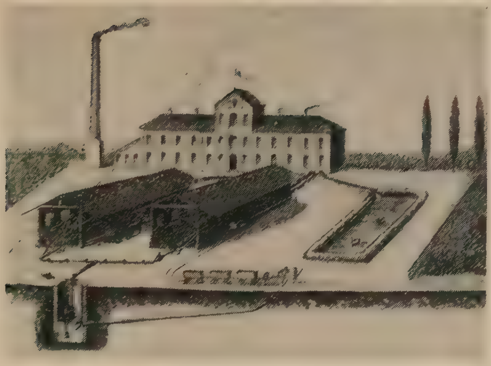

FIGURE 14.—Sugar beet factory showing sheds where the beets are washed by water forced through the troughs.

used as a fertilizer and the potash and nitrogen removed from the field by the beet crop may thus be returned to the soil. Vinasse is often mixed with some absorbent material such as peat before it is put on the fields.

The production of sugar beet seed is a very important branch of the German beet sugar industry. It is owing to scientific seed breeding that the yield of beets per acre and the sugar content have improved so much during the last 50 years. When the industry was in its infancy, the per cent of sugar in the beet was about one-half that of the sugar cane, whereas today the sugar content of beet has been increased threefold, and is now higher than in the best sugar cane. The modern sugar beet containing over 20 per cent of sugar was evolved from a root containing only 7 per cent of sugar.

Before the war Germany and Russia were the chief commercial producers of seed and grew nine-tenths of the world's supply. The other countries which grew sugar beets imported their seed. Since the war the Russian supply has dwindled, but Germany still holds first place for export of seed.

In 1859 Rabbethge and Giesecke established a sugar-beet seed farm at Klein Wanzleben, near Magdedurg, which since has grown to be the most extensive sugar beet seed enterprise in the world, comprising 13,000 acres. As the beet sugar industry spread from France and Germany to other countries, they also began to grow seed, but Germany put forth such efforts that the seed growers of other countries were soon driven from the markets of the world and Germany secured a practical monopoly of the business. The dependence of the world upon German seed in 1913 is shown below in Table 3.

TABLE 3

SUGAR PRODUCED FROM GERMAN SEED, 1913 *

(In Tons)

In Germany	3,003,768
In other countries	3,793,365
Total	6,797,133

* Palmer, T. G., *Sugar Beet Seed*, p. 104.

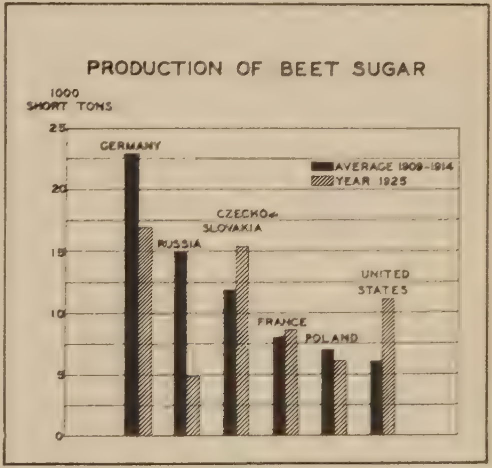

FIGURE 15.—Germany was the chief beet sugar producer in 1913. Though her 1925 production had not reached pre-war level, she had made a good recovery, and had a considerable surplus for export (see Figure 16). (Buechel, "Commerce of Agriculture" and International Crop Report.)

As the world total of beet sugar from all seed was approximately 8,770,000 [7] tons, it will be seen that about three-fourths of this was produced from German seed.

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[7] Buechel, F., *Commerce of Agriculture*, p. 288.

Fig. 15 shows the pre-war and 1925 production of beet sugar in the chief producing countries. The German output in 1913 was 2,304,000 tons, 26 per cent of the total world output, while Russia came next with 17.7 per cent, and the territory which is now included in Czecho-Slovakia contributed 13.9 per cent. The figures for the season 1924–1925 show a considerable drop in the German production. Russian production has declined from 1,557,000 tons to 501,977, about one-third of her pre-war production. The output in Czecho-Slovakia and the United States, on the other hand, shows considerable increase, while that of France is slightly in excess of the 1913–1914 production.

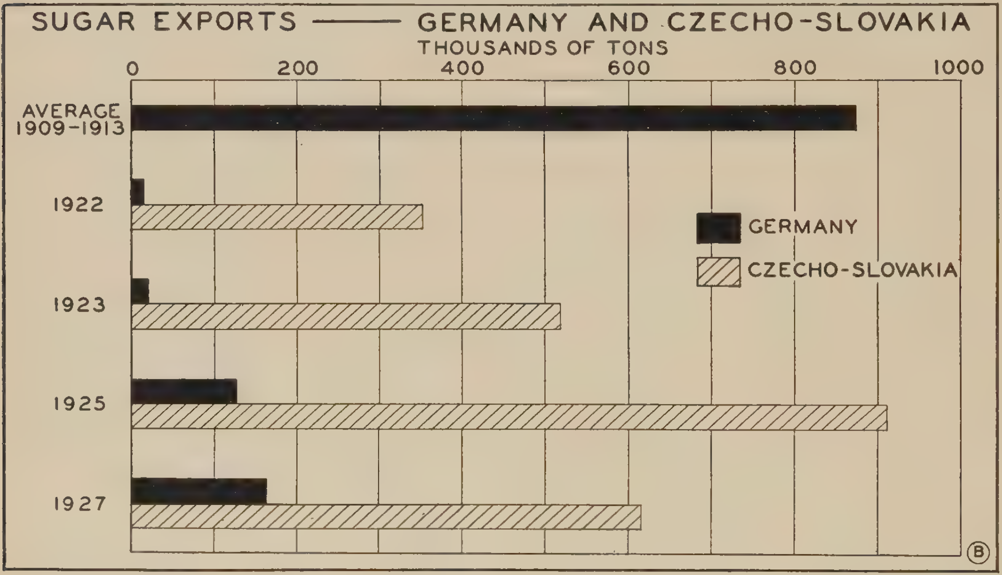

Figure 16.—Before the war Germany was the chief exporter of beet sugar. In 1922 her export was almost negligible, her place as exporter being taken by Czecho-Slovakia. At present, though Czecho-Slovakia still holds first place, the German export is steadily increasing. (Yearbook U. S. D. A., 1927.)

It is interesting to note that although Russia now has a higher acreage than Germany under sugar beet, 1,190,000 acres as against Germany's 905,000, the German sugar output is heavier than that of Russia by some 500,000 tons.[8] This is due to the fact that the yield of beets per acre is higher in Germany than in Russia. In 1923 the yield was 10.1 tons in Germany and only 4.8 tons per acre in Russia. This is due, to some extent, to the advanced state of agriculture in Germany as compared with methods in Russia.

Germany became a sugar-exporting country about 1871 when the exports exceeded imports by a round 21,000 tons. From that time until the season of 1917–1918 Germany's exports continued to be greater than her imports, reaching a maximum in 1910–1911 when the net export was 1,228,715 tons. The sugar sent abroad went chiefly to England. Probably about one-half of the average (1909–1913) exportable sugar surplus of 953,000 tons originated in the areas which Germany forfeited by the Treaty of Versailles. This meant a big loss to her international balance sheet.

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[8] *International Crop Report,* June 1926, p. 290–291.

In 1913 Germany was the most important beet sugar-exporting country, with Austria Hungary as close second and Russia third. The 1927 statistics (See Fig. 16) show that Czecho-Slovakia now leads in the export market, Germany stands second, while Russia has no surplus for export. Today Czecho-Slovakia is Germany's most dangerous competitor, but since 1922 German export of sugar has increased at a greater rate than that of Czecho-Slovakia, and if this continues Germany will resume her place at the head of the list of beet sugar-exporting countries.

The German sugar production from 1891 to 1926 is shown in Fig. 17. The trend is generally upward until the outbreak of the World War in 1914, with the exception of two noticeable drops in the years 1904 and 1911. In those years the temperature rose unusually high during the maturing season, especially in 1911. This is detrimental to the storage of sugar and no doubt resulted in smaller sugar content of the beet. Between 1914 and 1918 there was a marked decline, owing to the war, but immediately after the cessation of hostilities, fields which had been lying idle for lack of labor were planted with beets, hence the general upward trend of the curve as shown in Fig. 17.

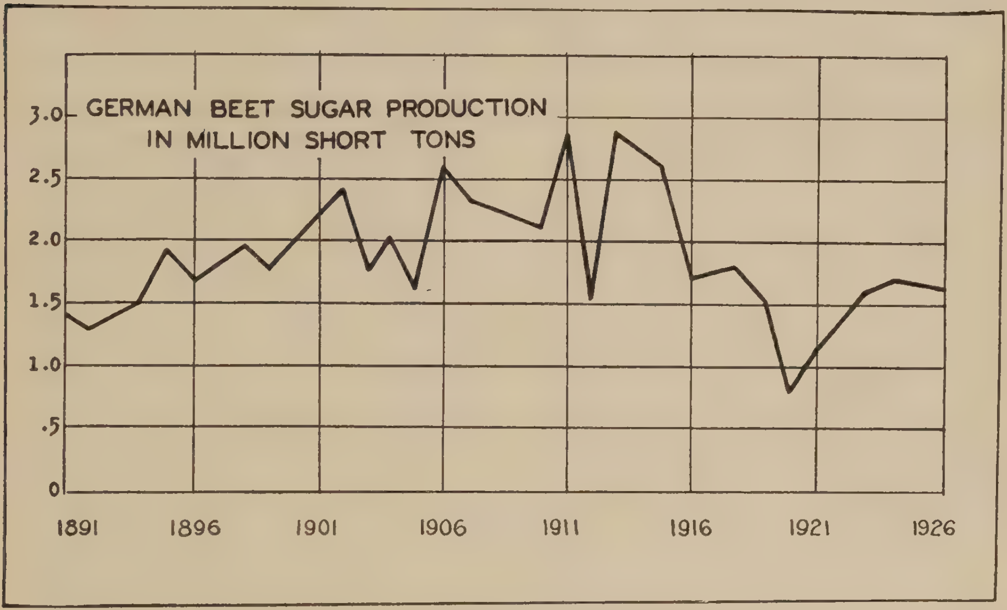

FIGURE 17.—The trend of the German sugar production was generally upward until the war, during which period most of the fields were idle. The upward trend, however, began immediately after the armistice. (Yearbook U. S. D. A., 1923, and International Crop Report, May, 1927.)

DIVISIONS OF THE PINE FOREST BELT OF EAST TEXAS

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THE Southern Yellow Pine and Hardwood Forest extends into East Texas approximately to the 40-inch rainfall line and is the natural vegetation of an area varying from 80 to 120 miles in width and extending from the northern boundary of the state to the Gulf Coastal Prairies. The area of this district (23,000 square miles) is about ten times that of Delaware and slightly more than half that of Pennsylvania, but it includes less than an eleventh of the vast state of Texas. It produces almost all the commercial timber output of the state which amounts to one and a half billion board feet annually, and gives Texas sixth or seventh rank among the states in lumber production. Farms in the district produce an average of 440,000 bales of cotton annually which is more than the total for Tennessee and Virginia and forms a tenth of the cotton crop of Texas. Corn is the chief supply crop of the farmer, and legumes and vegetables are produced for home consumption and marketing. Livestock industries have not attained large importance in the region.

This pine forest belt contains two geographic regions—a southern one in which exploitation of forest resources is the dominant economic activity, and a northern one in which agriculture is of outstanding importance.

PINEY WOODS REGION

The southern part of the East Texas Pine Forest Belt is an extensive woodland, cut-over, and forest region much of which is appropriately known as the "Big Thicket" by people living in adjoining areas. Land which is cleared and improved for farming is distributed in small bodies—veritable holes in the wilderness—chiefly in the vicinity of mill towns and the environs of the chief cities as Jasper, Lufkin, Livingston, and Huntsville. Most of the wage earners are engaged in lumbering, sawmilling, and the operation of turpentine camps. The population which gains a livelihood in these industries is the chief basis of wholesale and retail trade, and constitutes an important market for farm produce. The cities contain large sawmills and some other wood-working industries. Towns and rural communities develop at sawmills, logging fronts, and turpentine camps, and many of them are abandoned when the local timber supply is exhausted.

The first step in the utilization of a mature stand of longleaf pine (*P. palustris*) is its development as a turpentine camp. Undergrowth is cut from the forest so that it will not retard the gathering and transportation of the resin, and a turpentine still is erected beside a railroad at a place convenient to the forest and to a source of water for use in cooling the coils of the condenser. Negro laborers called "chippers" cut "streaks" in the trees, and attach galvanized iron aprons and cups to catch the sticky resin which oozes from the wounds. A fresh streak is "hacked" in each tree once a week during the

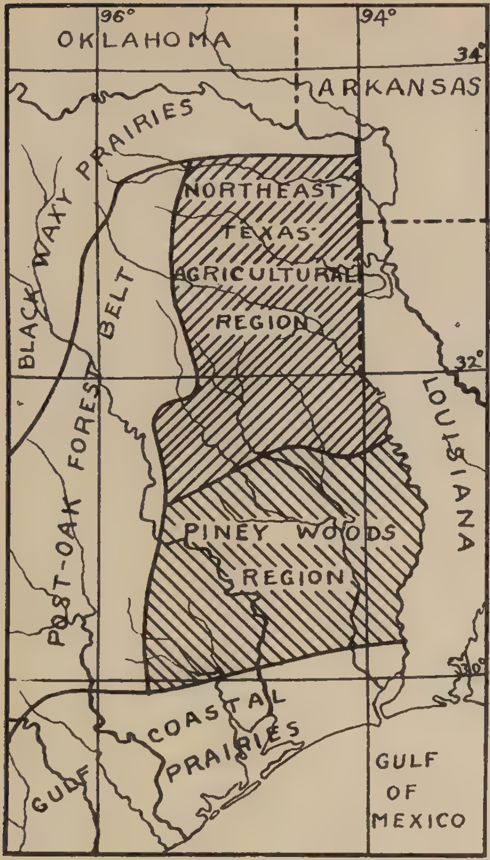

FIGURE 1.—The geographic regions in the Pine Forest Belt of East Texas.

growing season to keep the resin flowing freely. At intervals of ten to fourteen days the resin is collected in barrels, and hauled to the still where it is heated to evaporate the turpentine and moisture. The vapors are condensed, and the turpentine is separated from the water by a gravity process and collected in tank cars or metal drums for transportation to market. The residue is strained to remove chips, bark, and other trash, and poured into barrels to cool. It forms a brittle, amber-colored resin, which is used in the manufacture of soap, paper, and some other commodities.

When a forest has been used as a turpentine camp two or three years, the cups are moved to other trees, and it becomes a center of logging operations. A spur from the logging railroad is built in the area, and all trees suitable for use as saw timber and within 75 to 100 yards of the track are felled, and their long, straight trunks are cut into logs. A steam engine equipped with long cables to which hooks are attached is used in dragging or "skidding" logs into position beside the track. The logs are placed on cars by a "loader," and transported in train-loads to the mill which in some cases is located more than thirty miles from the logging front.

At the mill the logs are dumped into a pond, and towed to the "slip" up which they are carried by belt conveyers. They are placed on carriages, and moved against band saws which cut them into slabs. Belt conveyers and automatic rollers carry the slabs to other saws which trim off rough edges and cut the boards into standard sizes. Planing machines complete the process of manufacture, and the lumber is loaded upon cars for transportation to market. Some mills make laths from suitable slabs, and all of them use sawdust, shavings, and other scraps of wood as fuel for the boilers. Surplus scraps

FIGURE 2.—Highway through a pine forest which has been developed as a turpentine camp. Jasper County, Texas (Piney Woods Region).

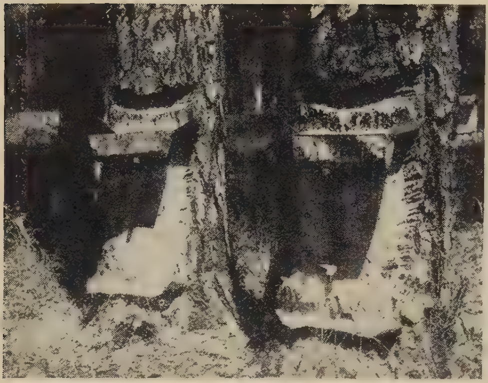

FIGURE 3.—The chippings on pine trees in a turpentine camp near Zavalla, Texas. At the outset the cup is attached at the base of the trunk, but it is raised and a new apron is inserted each spring when the sap begins to flow.

are sold for use as fire wood, or are dumped into the burner where they are reduced to ashes which have a small market value.

When lumbering operations are finished in an area, the site of the once stately forest becomes a desolate and almost abandoned waste. At the outset the cut-over land is littered with broken and twisted masses of branches and dotted with thousands of desolate stumps. A few solitary and slender pines, too small or imperfect for use as saw timber, stand above the forest wreckage, having survived the falling timber and the ravages of the powerful skidder. In many cases fire sweeps over the area burning the withered and rotting litter, deadening the larger trees, and consuming the young seedlings which spring up in the sandy soils of the warm and humid region. Piney-woods-rooters, goats, and other livestock range upon the land unless it is fenced, devouring seedlings and retarding the development of second growth timber. Notwithstanding these handicaps the forest has reëstablished itself in many places, and it is hoped that the work of the State Department of Forestry and the economic interests of land owners will lead to the reforestation of all land unsuited to higher uses.

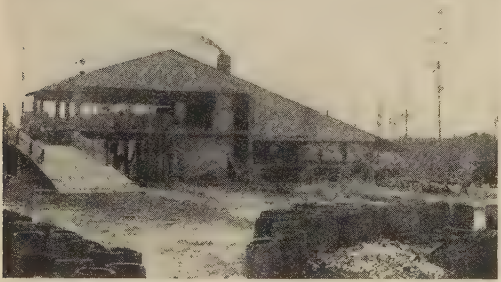

FIGURE 4.—Turpentine still in operation in the northern part of Newton County, Texas. Resin is brought from the camp in barrels similar to those in the foreground, and delivered beside the still from the elevated drive at the left.

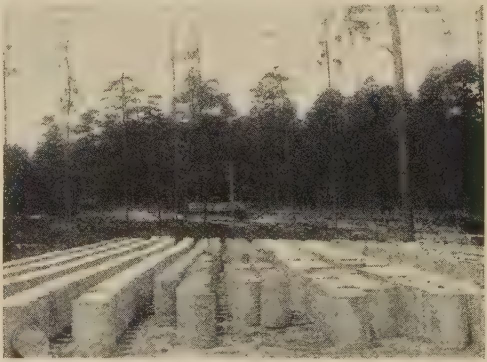

FIGURE 5.—Galvanized iron barrels of resin in the foreground, and a tank car of turpentine and virgin pine forest in the background.

Agriculture is still of secondary importance in the Piney Woods Region. Some land was settled before the rise of the lumber industry and agriculture has developed some in recent years, but less than a fifteenth of the total area is used in crop production. Factors which have retarded the growth of the industry are the low productivity of cotton and corn when planted in deep sand soils, the inadequate market for vegetable and fruit crops which thrive in the region, the difficulty of

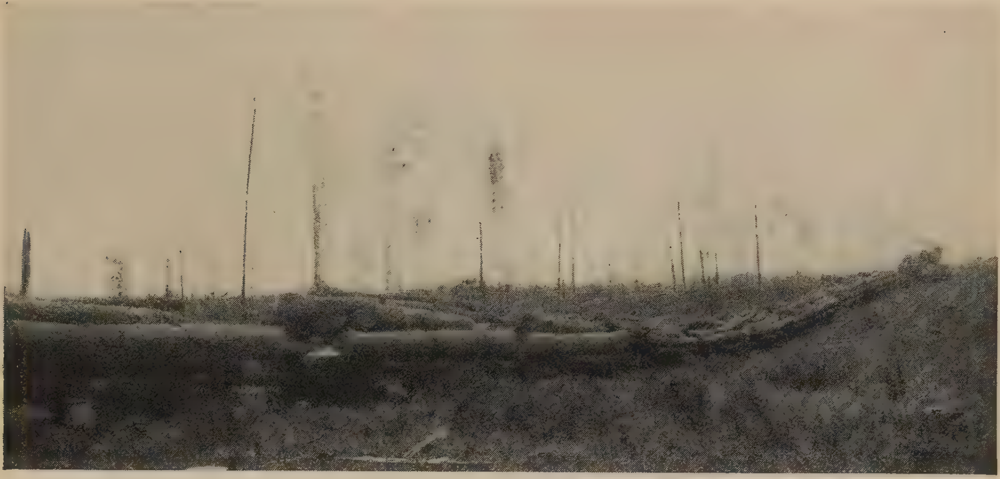

FIGURE 6.—Logging train in a cut-over area in Newton County, Texas.

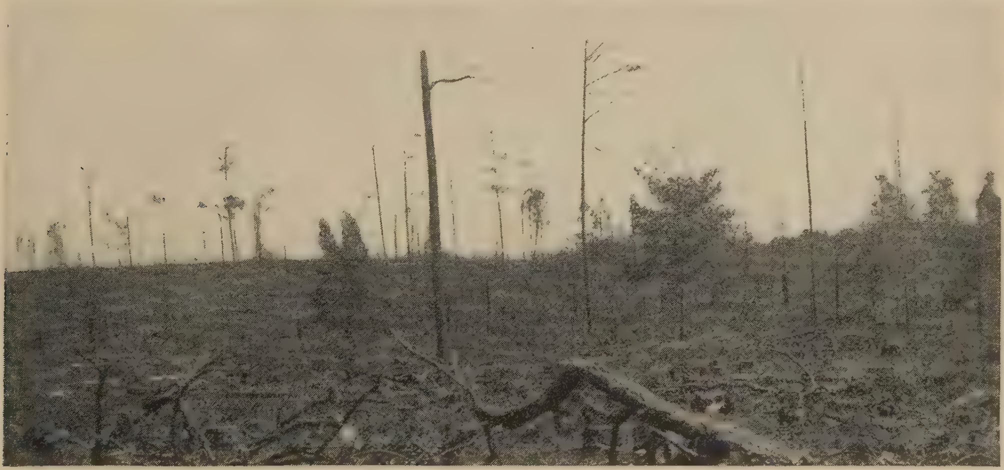

FIGURE 7.—Cut-over land near Jasper, Texas.

clearing cut-over land, and the unwillingness of some lumber companies to sell land to farmers. Cotton occupies half of all the land in crops and half as much is planted in corn. These crops are so poorly suited to the land that heavy fertilization and intelligent soil-building are essential to successful production. Ribbon cane, a variety of sugar cane, is grown on alluvial land and used in making molasses. Small quantities of peanuts, sweet potatoes, watermelons, peas, and figs are also produced. These crops yield feeds for livestock and foods for home use and for sale in the mill towns and small cities.

Livestock industries are based upon the utilization of unfenced forest and cut-over land as range for cattle, goats, hogs, and sheep. Beef cattle are more than five times as numerous as dairy cows, for they are well suited to life on the range and require relatively little care. They vary from pure-bred to scrub animals, and are shipped to packing plants or slaugh-

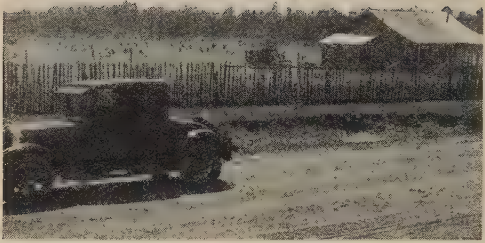

FIGURE 8.—Farmstead on highway in the central part of the Piney Woods Region.

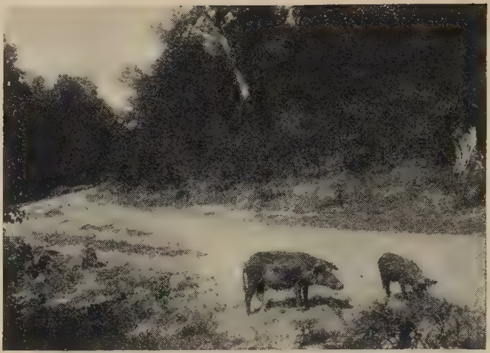

FIGURE 9.—"Piney-Woods-Rooter" and the remnant of her litter in their habitat. Hogs of this type, the product of the struggle for survival in the Piney Woods Region, are being improved by crossing with pure blooded and grade stock.

tered for sale in local markets. Many goats are raised, for they thrive in the forest and are useful in killing sprouts and as a source of meat. Grade hogs and "piney-woods-rooters" feed by the "root hog or die" system on pine seedlings, roots, acorns, and nuts which they find in the forest. Some sheep are grown in grassy, cut-over areas, but they are poorly suited to range life in this warm, moist, wolf-infested land. Chickens and other poultry are unimportant because of the ease with which they fall prey to wild life of the forest including hawks, owls, foxes, and opossums.

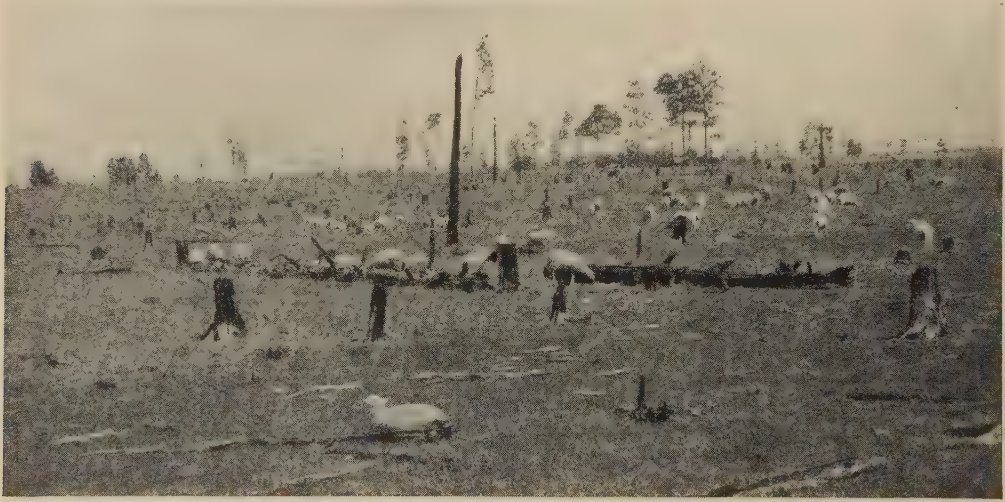

FIGURE 10.—Some sheep are raised in grassy, cut-over areas in the Piney Woods Region.

NORTHEAST TEXAS AGRICULTURAL REGION

Conquest of the forest and development of agricultural industries have made much greater progress in the northern part of the East Texas Pine Forest Belt than in the Piney Woods Region. The presence of sandy loam soils and rather open forest made the area attractive to settlers, and its early occupation was favored by proximity to the sources of Anglo-American migration to Texas and by location on the Old San Antonio Road

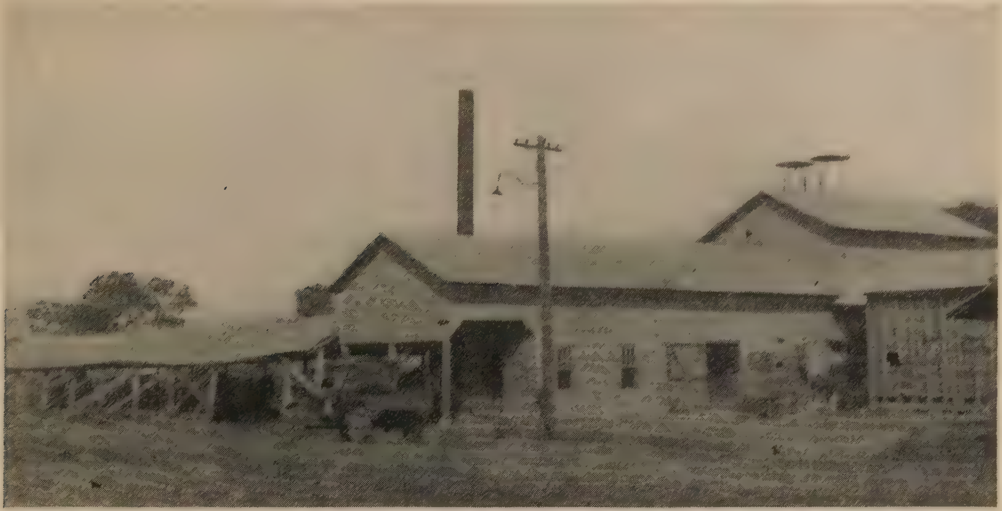

FIGURE 11.—Ginning cotton at Kilgore, Texas. Note the long shed at the left which gives protection from sun and rain to farmers and their seed cotton while waiting to be served at the gin.

along which that migration moved. The early settlements expanded, and the land was divided into farms, so that lumber companies never gained possession of the soil, and agriculture has developed with the conquest of the forest and the improvement of transportation and marketing facilities.

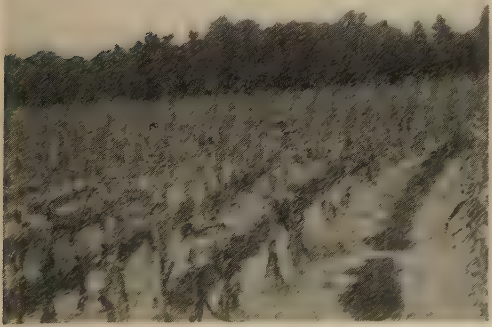

FIGURE 12.—Corn and peanuts grown in alternate rows on sandy soil in the Northeast Texas Agricultural Region.

Agriculture is the dominant industry of the region. Approximately 60 per cent of the land is in farms, and half of this amount is cultivated. Typical rural landscapes contain small, undulating, sandy and sandy loam fields interspersed with patches of second growth pine and hardwood forest and dotted with the modest homes of farmers and tenants. More than a fourth of the total area is used in the production of cotton and corn, and there are several legume, vegetable, and fruit crops. Farm woodlands occupy much poor, sandy, and rugged land and alluvial areas which are subject to frequent overflow. Livestock industries are small but dairying is increasing in importance. The region is threaded by railroads and a system of highways and roads which make the towns and villages accessible and converge at the chief urban centers as Texarkana, Marshall, Tyler, Longview, and Nacogdoches. These cities are centers of retail and wholesale trade and have some manufacturing industries.

Cotton is grown on 61 per cent of all the land in crops, and is the chief basis of prosperity among the people. Farmers derive most of their income

FIGURE 13.—Field peas growing on white sand land near Henderson, Texas.

from the sale of staple, and the seeds are used as livestock feeds and fertilizer or in the manufacture of cotton seed oil, cotton seed meal, cotton seed hulls, and linters. The supremacy of the crop is indicated by the large part of the cultivated land it occupies, by the large number of workers who cultivate and harvest the crop, by the location of gins in every community and at road intersections in rural areas, by the presence of cotton compresses, cotton seed oil mills, and cotton yards and warehouses in the chief towns and cities, and by the numerous loads of seed cotton, cotton bales, cotton seeds, and cotton seed products which move by wagon and truck along the roads and highways. Promise of a good yield and a high price for the staple causes optimism and anticipation of prosperity, while the prospect of a small crop and low market value forebodes business depression and financial stringency.

The corn crop is second only to cotton in value to the farmer. It occupies about a third as much land as cotton and more than the total for all other field crops. Good yields are obtained on alluvial and loam upland soils, but the average grain yield is reduced to less than 10 bushels per acre by the niggardly crops obtained on sand soils and in poor, eroded fields. The yield is also reduced by the practice of growing peas, peanuts, and beans in alternate rows with corn. The grain is used in feeding horses, mules, milch cows, and other livestock, and is an important breadstuff of the population. Since the crop is inadequate to supply the demand, quantities of corn are shipped into the area from Oklahoma and Kansas.

This cotton and corn growing system of farming has serious deficiencies, but it has survived every attack. The two crops compete for the best land, for neither will yield well on deep sand soil or poor eroded land without liberal fertilization. They compete for labor because each crop is planted in the spring, each requires cultivation during the early part of the growing season, and each is ready to harvest during the late summer and autumn. Since both cotton and corn are intertilled, their production on 88 per cent of all land in crops accentuates the problem of erosion, so that terracing is advisable even on land having gentle slopes. Notwithstanding these handicaps farmers continue to grow cotton and corn because of the excellence of cotton as a

FIGURE 14.—Sweet potatoes ready for harvesting. This crop was grown on sandy soil near Center, Texas, and marketed in Shreveport.

Figure 15.—Field of ribbon cane, a variety of sugar cane, north of Henderson, Texas. This crop is planted on rich alluvial land, and is used in making molasses.

money crop and the value of cotton seeds and corn as supply crops. Other crops are less suitable for large-scale production in the region than these staples, and a program for agricultural development should include the practice of soil-building methods of farming and the production of more cotton and corn per acre.

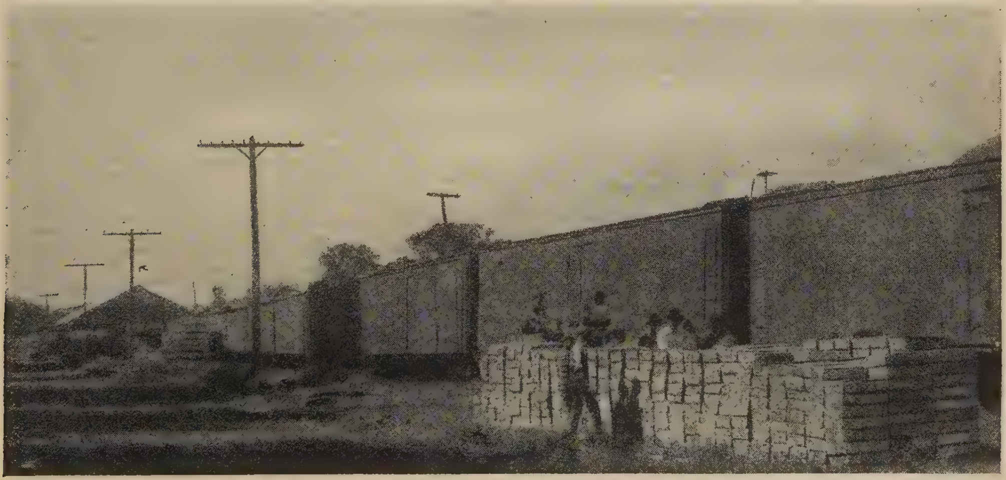

Figure 16.—Loading tomatoes for shipment at Dialville, Texas. The crates ricked in the foreground were packed and hauled to the railroad siding by farmers. Tomatoes brought in bulk for shipment are sorted and packed in the long shed in the left background.

Several legumes grow luxuriantly in the loam and sandy soils of the region. They are planted in small fields or in alternate rows with corn, and supply quantities of food for the population and forage and hay for livestock. Peanuts are hogged down, or are pulled, cured, and stored for winter use. The vines make excellent hay if relatively free of sand, and the nuts are useful as a food and as feed for swine. Stock-peas and velvet beans are grown; and speckled peas, blackeyed peas, and crowder peas are prized as foodstuffs by the population. These crops reduce the cost of living, foster the growth of livestock industries, and tend to increase soil fertility.

The long moist growing season, short mild winters, and abundance of sandy soil favor the growth of vegetables and some berries and fruits. Sweet potatoes, watermelons, tomatoes, and ribbon-cane are important crops. A variety of garden vegetables and figs, peaches, and berries are grown for home use and sale in local markets, and quantities of tomatoes, sweet potatoes, watermelons, and peaches are shipped to market in the North and East. The commercial crop is produced early in the growing season, for the sandy and loam soils become dry and warm early so that these crops mature while prices are sufficiently high to make their transportation to distant markets profitable. Expansion of the industry is limited by the capacity of available markets at prices which give moderate return to farmers, for only a small portion of the land suited to the industry is now used in production. Efforts are being made to develop a canning industry and conserve the late part of the crop which is almost valueless under present conditions.

FIGURE 17.—Farm woodland which has a dense stand of young pine. Much sandy and slope land in the Northeast Texas Agricultural Region should be used in growing pine trees.

Dairying is the most thriving livestock industry of the region. Dairy cattle are five times as numerous as in the Piney Woods Region, and the industry is growing in the vicinity of the larger urban centers and along railways which offer service to Shreveport and Dallas. The long, moist growing season facilitates the production of stock feeds including cotton seeds, corn, sorghum, stock-peas, and velvet beans; and by growing oats, rye, wheat, turnips, and vetch during the winter, ample supplies of succulent feed can be obtained to keep dairy cattle in prime condition at all seasons. The success of the industry is also favored by the small cost of protecting cows from cold, inclement weather, and the ease with which the animals maintain body heat in winter. The eradication of tick fever and the preservation of dairy products in hot weather are not difficult in this age of medical science and of manufactured ice which is available at moderate prices for use in refrigeration. Dairying will develop as the cities in the region and in adjoining areas increase in size, and future production may enable the shipment of butter, condensed milk, and cheese to distant markets.

Other livestock industries are less promising than dairying. Beef cattle and hogs are less numerous than in the Piney Woods Region, for production is limited by the scarcity of feeds suitable for use in fattening animals and the absence of free range for livestock. Poultry is more abundant than in the Piney Woods Region because agriculture is better developed and wild life less abundant than in that area, but goats are unimportant since they are not needed in checking forest growth and free range is not available.

Forest industries consist chiefly in cutting timber on farm woodlands which occupy about 25 per cent of all land in the region. There are no large-scale logging fronts or turpentine camps, but quantities of poles, posts, railroad ties, saw timber, and fire wood are cut especially during the winter. Short leaf pine is the most abundant and valuable tree. It thrives in deep sand and old field land and in areas having steep slopes. Oak, gum, elm, pecan, and other hardwoods grow in alluvial land. The farm woodlands receive little care, but half of them have a fair stand of timber and they supply wood for use on the farm and much marketable material.

FUTURE UTILIZATION OF THE PINE FOREST BELT

These two regions in the Pine Forest Belt of East Texas seem destined to retain geographic individuality. The Piney Woods Region has an enormous acreage of sand and slope land which is unsuited to cultivation. Much of it has a stand of second growth pine, and most of it will probably be used to grow successive crops of timber, thus perpetuating the forest character of the region and its forest and wood-working industries. Production of vegetable and fruit crops which thrive in the region will increase with the growth of accessible markets and the improvement of transportation and marketing facilities, but farming based on the growth of cotton and corn will not succeed in most parts of the area. On the other hand agricultural industries will continue to develop in the Northeast Texas Agricultural Region with tendencies toward greater diversification and intensification in crop production, and increasing attention to livestock industries, especially dairying. Forest industries will be confined to the cutting of timber on farms. Textile mills and some other kinds of factories will probably develop in the cities and towns to make finished products from cotton, wood, milk, vegetables, and fruits produced in the region and use lignite coal mined in the area and the moderate-priced labor of the population.

BOOK REVIEWS

Department of Commerce

Bureau of Foreign and Domestic Commerce

Commerce Yearbook, 1929, Volumes I and II

The first volume was issued recently, and the second volume has just now been released.

Together these two books comprise a comprehensive survey of the United States and foreign countries. Volume I contains detailed information concerning business conditions in the United States and its noncontiguous territories and possessions. It opens with a brief summary of business conditions in the United States for 1928, based upon the most reliable and recent statistical data available in the Department of Commerce and throughout the Government. This is followed by chapters which discuss thoroughly such subjects as recent movements of production and domestic trade; general economic position and progress of the United States; employment, immigration and wages; and the question of wholesale and retail and farm prices. The foreign trade of the United States is given careful consideration from the standpoint both of commodities and regional distribution. Another section of the book deals with agricultural products and foodstuffs. Other commodities, such as fuel and power, construction materials, iron and steel, machinery, automotive products, rubber and rubber products, and in fact all of the important commodities in American manufacture and trade are analyzed.

Volume II—Foreign Countries—has come to be a unique contribution to American business thought. In securing information and statistical data to be used in this volume, the Department of Commerce has enlisted the coöperation of many foreign Governments, who have gladly furnished it immediately and as soon as available, with the latest statistics. This has involved a veritable worldwide enterprise and coöperative activity, carried on principally through the foreign offices of the Department of Commerce throughout the world, and the Consular service of the Department of State.

Through these agencies valuable material available to the geographer and the economist, as well as the business man, from no other source, is compiled within this volume.

Some sixty-five foreign countries are handled separately. Statistics of production and trade, area and population, communications including railways, posts, telegraphs, telephones, and airway information, in addition to finance and currency, are among those given for practically all these countries.

The information at hand has been analyzed carefully, and results given in the text of the book.

Maps and graphs add greatly to the value of these publications. In addition to the black and white maps in the text are a series of colored continent maps at the end of the book.

This volume also is available at $1.00 from the same source as Volume I.

The publications of this bureau may also be purchased from the bureau of its district offices.

Annual Report of Director of Bureau of Foreign and Domestic Commerce to Secretary of Commerce for Fiscal Year Ended June 30, 1929.

Reviews the activities of the bureau during the past year, showing the part taken by each division. Price, 10 cents.

Index to Commerce Reports, Nos. 26–39, Volume 3, Thirty-second Year, July–September, 1929.

This index is issued quarterly and lists all material published in Commerce Reports by subject, country, and author. Single copies, 5 cents; annual subscription, 20 cents.

South American Markets for Rubber Sundries and Specialties. Trade Information Bulletin No. 658. Price, 10 cents.

Discussion of the extent of the market for rubber goods, competitive conditions, and methods of doing business in the various countries of South America.

Rights of Foreign Shareholders of European Corporations. Trade Information Bulletin No. 659. Price, 10 cents.

Markets for Building Materials: Part II, Mexico, Central America, and West Indies. Trade Information Bulletin No. 660. Price, 10 cents.

Discussion of the kinds of building materials produced and imported in Mexico, Central America, and West Indies.

Leather Trade of Italy. Trade Information Bulletin No. 661. Price, 10 cents.

Market for Foodstuffs in Colombia. Trade Information Bulletin No. 662. Price, 10 cents.

Monthly Summary of Foreign Commerce of United States, July, August, and September, 1929. Part I and II.

Part I contains statistics of exports of domestic merchandise, and imports by articles for July, August, and September, 1928 and 1929, and for seven months ended July, August, and September, 1928 and 1929. Part II contains summaries of export and import trade; monthly average import and export prices; and statistics of trade with Alaska, Hawaii, and Porto Rico. Single copies, Part I, 10 cents; Part II, 5 cents. Annual subscription, $1.25.

Latin American and Canadian Markets for American Motion-Picture Equipment. Trade Information Bulletin No. 641.

Marketing of Tungsten Ores and Concentrates. Trade Information Bulletin No. 643. Price, 10 cents.

Summary of the properties, uses, world sources, and methods of marketing tungsten ore and concentrates.

British Trade in Rubber and Rubber Products. Trade Information Bulletin No. 644. Price, 5 cents.

Discussion of the crude-rubber production of the British Empire, the production restriction measures adopted and their abandonment, the manufacture of rubber goods in Great Britain, and the British trade in these products.

Export Markets for American Brushes. Trade Information Bulletin No. 645. Price, 5 cents.

Boot and Shoe Industry and Trade in Germany. Trade Information Bulletin No. 646. Price, 10 cents.

Cattle Raising in Argentina. Trade Information Bulletin No. 647. Price, 5 cents.

Discussion concerning cattle raising and the development of the packing industry in Argentina.

Installment Selling of Automobiles in Latin America. Trade Information Bulletin No. 649.

Foreign Trade of United States in Fiscal Year 1928–1929. Trade Information Bulletin No. 650; ii and 22 pages.

Leather Trade of Egypt. Trade Information Bulletin No. 651. Price, 5 cents.

Deals with the production of hides and skins, the methods of tanning, and the leather trade of Egypt.

Representative International Cartels, Combines, and Trusts. By William F. Notz. Trade Promotion Series No. 81. Price, 15 cents.

Appointments to Positions at Home and Abroad in Bureau of Foreign and Domestic Commerce.

Prison Industries. Domestic Commerce Series No. 27. Price, 20 cents.

Sales Territories in Japan. By Paul P. Steintorf, American Trade Commissioner.

French Chemical Industry and Trade in 1928. Trade Information Bulletin No. 652. Price, 10 cents.

Big Five in Japanese Banking. Trade Information Bulletin No. 653.

Budgets of European Countries, 1929: Part II, Western and Central Europe. Trade Information Bulletin No. 654.

Markets for Building Materials: Part I, Canada and Newfoundland. Trade Information Bulletin No. 655.

French Experience with Defaulted Foreign Bonds. Trade Information Bulletin No. 656. Price, 10 cents.

Latin American Financial Developments in 1928. Trade Information Bulletin No. 657. Price, 10 cents.

Automotive Market in Argentina. By Howard H. Tewksbury, American Trade Commissioner. Trade Promotion Series No. 84. Price 20 cents.

BUREAU OF THE CENSUS

Census of Manufactures, 1927:

- *Buttons.* Price, 5 cents.
- *Manufactured Ice, Refrigerators and Refrigerator Cabinets, and Mechanical Refrigerators.* Price, 5 cents.
- *Petroleum Refining.* Price, 5 cents.
- *Tanning Materials, Natural Dyestuffs, Mordants and Assistants, and Sizes.* Price, 5 cents.
- *Wood Preserving, Compiled in Coöperation with Department of Agriculture Forest Service.* 7 pages. Price, 5 cents.
- *Artificial Leather, Linoleum and Asphalted-Felt-Base Floor Coverings, Oilcloth.* Price, 5 cents.
- *Asbestos Products and Stone, Clay, and Glass Industries Not Covered by Separate Reports.* Price, 5 cents.
- *Cash Registers, Adding Machines, and Calculating Machines; Gas Machines and Gas and Water Meters; Scales and Balances; Typewriters and Supplies.* Price, 5 cents.
- *Chocolate and Cocoa Products, Confectionery and Chewing Gum.* Price, 5 cents.
- *Drug Industries: Druggists' Preparations, Patent and Proprietary Medicines and Compounds, Perfumes, Cosmetics, and Other Toilet Preparations; Drug Grinding; Essential Oils.* Price, 5 cents.
- *Flour and Other Grain-Mill Products, Cereal Preparations, Prepared Feeds for Animals and Fowls, Bread and Other Bakery Products.* Price, 10 cents.
- *Hats and Millinery: Hats, Wool-Felt; Hats, Fur-Felt; Hats, Men's Straws; Hats and Caps, Except Felt and Straw; Hat and Cap Materials; Millinery.* Price, 5 cents.
- *Lime and Marble, Granite, Slate, and Other Stone Products.* Price, 5 cents.
- *Milk Products: Butter, Cheese, and Condensed and Evaporated Milk, Ice Cream.* Price, 5 cents.
- *Miscellaneous Fiber and Textile Products: Cordage and Twine; Jute Goods; Linen Goods; Dyeing and Finishing Textiles; Flax and Hemp, Dressed; Haircloth; Mats and Matting, Grass and Coir; Waste.* Price, 5 cents.
- *Ship and Boat Building.* Price, 5 cents.
- *Stoves and Ranges, Heating Apparatus, and Steam Fittings, Plumbers' Supplies, Not Including Pipe or Vitreous-China Sanitary Ware.* Price, 5 cents.

Women in Gainful Occupations, 1870–1920, Study of Trend of Recent Changes in Numbers, Occupational Distribution, and Family Re-

lationship of Women Reported in Census as Following Gainful Occupation. By Joseph A. Hill. Census Monographs IX. Price, $1.50.

Earnings of Factory Workers, 1899–1927, Analysis of Pay-Roll Statistics. By Paul F. Brissenden. Census Monographs X. Price, $1.50.

Financial Statistics of Cities Having Population of Over 30,000. 1927. Price, $1.25.

Prisoners' Antecedents: Statistics Concerning Previous Life of Offenders Committed in 1923 to State and Federal Prisons and Reformatories, Supplementary to "Prisoners, 1923." Price, 15 cents.

BUREAU OF FISHERIES

Annual Report of Commissioner of Fisheries to Secretary of Commerce for Fiscal Year Ended June 30, 1929. Price, 5 cents.

Review of Weakfishes (Cynoscion) of Atlantic and Gulf Coasts of United States, with Description of New Species. By Isaac Ginsburg. Document No. 1058. (From Bulletin of Bureau of Fisheries, Vol. XLV, 1929, pp. 71–85.) Price, 10 cents.

Whitefish, Grayling, Trout, and Salmon of Intermountain Region. By S. B. Locke. Document No. 1062. (Appendix V to Report of Commissioner of Fisheries for Fiscal Year 1929, pp. 173–190.) Price, 10 cents.

Keokuk Dam and Fisheries of Upper Mississippi River. By Robert E. Coker. Document No. 1063. (From Bulletin of Bureau of Fisheries, Vol. XLV, 1929, pp. 87–139.) Price, 30 cents.

Alaska Fishery and Fur-Seal Industries in 1928. By Ward T. Bower. Document No. 1064. (Appendix VI to Report of Commissioner of Fisheries for Fiscal Year 1929, pp. 191–332.) Price, 25 cents.

Bibliography on Cod-Liver Oil in Animal Feeding, with Non-critical Comments and Abstracts. By John Ruel Manning. Document No. 1065. (Appendix VII to Report of Commissioner of Fisheries for Fiscal Year 1929, pp. 333–365.) Price, 10 cents.

BUREAU OF MINES

Nineteenth Annual Report of Director of Bureau of Mines to Secretary of Commerce for Fiscal Year Ended June 30, 1929. Price, 10 cents.

Report on the various activities of the bureau during the year.

Facts relating to Production and Substitution of Manufactured Gas for Natural Gas. By William W. Odell. Bulletin 301. Price, 35 cents.

Ochers and Mineral Pigments of Pacific Northwest: Occurrence, Possible Methods of Preparation, and Testing of Ochers, Siennas, and Colored Clays. By Hewitt Wilson. Bulletin 304. Price, 15 cents.

Mining Methods and Practice in Michigan Copper Mines. By W. R. Crane. Bulletin 306. Price, 60 cents.

Flow of Gases Through Beds of Broken Solids. By C. C. Furnas. Bulletin 307. Price, 30 cents.

Study of physical and chemical reactions of the flow of gases through beds of broken solids in blast furnaces.

Drilling and Blasting in Metal-Mine Drifts and Crosscuts. By E. D. Gardner. Bulletin 311. Price, 40 cents.

Summarized Data of Gold Production. By Robert H. Ridgway. Economic Paper 6. Price, 20 cents. Information regarding production of gold in different countries of the world.

Economics of New Sand and Gravel Developments. By J. R. Thoenen. Economic Paper 7. Price, 15 cents.

Advanced Mine Rescue Training: Part II, Instructions in Methods of Sampling and Use of Bureau of Mines Portable Orsat Apparatus for Analyzing Mine Gases. By W. P. Yant and L. B. Berger. Miners' Circular 34. Price, 20 cents.

Mineral Resources of United States, 1926: Part I, Metals. Price, $1.25.

Mineral Resources of United States, 1928:
- Iron Ore, Pig Iron and Steel in 1928. (Pt. I, pp. 29–68.) Price, 10 cents.
- Platinum and Allied Metals in 1928. (Pt. I, pp. 7–20.) Price, 5 cents.
- Slate in 1928. (Pt. II, pp. 41–53.) Price, 5 cents.
- Sulphur and Pyrites in 1928. (Pt. II, pp. 55–65.) Price, 5 cents.

Analysis of Kansas Coals. Technical Paper 455. Price, 10 cents.

Mineral Resources of United States, 1927:
- Gold, Silver, Copper, Lead, and Zinc in Arizona in 1927. (Pt. I, pp. 731–744.) Price, 5 cents.
- Gold, Silver, Copper, Lead, and Zinc in Utah in 1927. (Pt. I, pp. 637–676.) Price, 10 cents.

Mineral Resources of United States in 1928 (Preliminary Summary). Introduction by Frank J. Katz; statistics assembled by Martha B. Clark. Price, 20 cents.
- Carbon Black in 1928. (Pt. II, pp. 31–35.) Price, 5 cents.
- Fuller's Earth in 1928. (Pt. II, pp. 37–40.) Price, 5 cents.

BUREAU OF NAVIGATION

American Documented Seagoing Merchant Vessels of 500 Gross Tons and Over, August, 1929. Published monthly. Single copies, 10 cents; annual subscription, 75 cents.

Annual Report of Commissioner of Navigation to Secretary of Commerce for Fiscal Year Ended June 30, 1929. Price, 5 cents.

American Documented Seagoing Merchant Vessels of 500 Gross Tons and Over, October, 1929. Published monthly. Single copies, 10 cents; annual subscription, 75 cents.

Same, November, 1929.

Seagoing Vessels of United States, 1929. Price, 75 cents.

American Documented Seagoing Merchant Vessels of 500 Gross Tons and Over, September, 1929. Published monthly. Single copies, 10 cents; annual subscription, 75 cents.

COAST AND GEODETIC SURVEY

Tide Tables, United States and Foreign Ports for Year 1930. Serial No. 439. Price, 75 cents.

This publication contains tables showing the rise and fall of tide for every day of the year at the important ports of the world. It also gives the time of the rising and setting of the sun and moon in various parts of the world.

Distances Between United States Ports. Serial No. 444.

This is one of the Coast Pilot Series.

Catalogue of Charts, Maps, Coast Pilots, Tide Tables, and Current Tables of Philippine Islands, August 1, 1929. Serial No. 451.

Catalogue of U. S. Coast and Geodetic Survey Charts, Maps, Coast Pilots, Tide Tables, Current Tables, September 1, 1929. Serial No. 454.

Precise Leveling in Texas. By H. G. Avers. Special Publication No. 77. Price, 25 cents.

Contains surveying data for the State of Texas.

Tidal Bench Marks, State of Massachusetts. By L. A. Cole. Special Publication No. 155. Price, 10 cents.

Descriptions and elevations of tidal bench marks on Massachusetts coast.

Annual Report of Director, United States Coast and Geodetic Survey, to Secretary of Commerce for Fiscal Year Ended June 30, 1929. Price, 15 cents.

United States Coast Pilot, West Indies: Porto Rico and Virgin Islands. Serial No. 446. Price, 75 cents.

Manual of First-Order Leveling. By Henry G. Avers. Special Publication No. 140. Price, 30 cents.

Contains general surveying instructions of the Coast and Geodetic Survey, with a summary of methods employed by the Survey in field and office computations.

Instructions, Primary Tide Stations. Special Publication No. 154. Price, 10 cents.

Instructions for collecting data for the rise and fall of tide in any locality and for the study of crustal movements in the earth.

LIGHTHOUSE SERVICE

Annual Report of Commissioner of Lighthouses to Secretary of Commerce for Fiscal Year Ended June 30, 1929. Price, 5 cents.

Report on the activities of the Lighthouse Service during 1929, with statistical data on aids to navigation.

OFFICE OF THE SECRETARY

Annual Report of Director of Aeronautics to Secretary of Commerce for Fiscal Year Ended June 30, 1929.

Airports and Landing Fields. Aeronautics Bulletin No. 5.

Airworthiness Requirements of Air Commerce Regulations. Aeronautics Bulletin No. 7-A.

Customs Ports Authorized to Issue Marine Documents. Ninth edition of Department Circular No. 249; 2 pages.

Radio Service Bulletin, September, October, 1929.

Issued monthly by the Radio Division of the Department of Commerce. Contains list of radio stations and references to current radio literature. Single copies, 5 cents; annual subscription, 25 cents.

Air Commerce Bulletin, September 15, 1929.

Air Marking. Aeronautics Bulletin No. 4.

Description of the system recommended by the Department of Commerce for marking aviation landing fields, airports, and direction indicators on roofs of buildings.

Air Commerce Regulations. Aeronautics Bulletin No. 7.

Airport Management. Aeronautics Bulletin No. 17.

Suggested City or County Aeronautics Ordinance and Uniform Field Rules for Airports. Aeronautics Bulletin No. 20.

Air Commerce Bulletin, August, September, October, November, 1929.

Radio Service Bulletin, July, 1929. Price, 15 cents.

Issued monthly by the Radio Division of the Department of Commerce. Contains list of radio stations and references to current radio literature.

Survey of Non-utilized Wood in North Carolina, Report of Sub-committee of National Committee on Wood Utilization Coöperating with State of North Carolina Department of Conservation and Development. Price, 20 cents.

Study of the forest resources of North Carolina, the amount of non-utilized wood produced, and methods of disposal of this wastage.

HELEN M. STRONG.

A Map of the World's Drugs. National Wholesale Druggists' Association, New York. 1929. Compiled by Edwin L. Newcomb.

The National Wholesale Druggists' Association of New York has recently published a drug map of the world, on Mercator's projection, measuring 35 x 61 inches, intended to be displayed in drug-store windows during "National Pharmacy Week," which was the third week in October. It was compiled by Edwin L. Newcomb, and shows the approximate sources of about 225 standard drugs, by means of their names inserted at the proper places. The drugs named are those which come from more or less restricted regions, and they are nearly all crude vegetable drugs; for products of animal origin (such as honey, beeswax, cod-liver oil, and lard) and manufactured, synthetic, and inorganic drugs, can be produced in almost any country.

The first glance at the map shows that drug plants are very unevenly distributed over the earth. It is not surprising that they are scarce or absent in cold and arid regions; but there is a marked concentration of them in many mountainous regions. This may of course be mostly because mountains generally retain much of their original wild flora, while most medicinal plants which may have originally inhabited fertile plains have given way to cultivated crops. But it is also possible that the soil has something to do with it. For some reason not at present understood, medicinal plants seem to be scarce in both acid and alkaline soils; but mountains on the whole seem to have soils approximately neutral. Such a soil preference is suggested by the scarcity of drug plants in the pine lands of the southeastern coastal plain where acid soils predominate, and in the western half of the United States where the soils are generally alkaline, except in the mountains where precipitation exceeds evaporation.

Another interesting coincidence is that most of the medicinal plants in the United States seem to grow where the early and late summer precipitation is approximately equal; but this may be merely one of the factors that determines the soil conditions. Information is lacking at present as to whether a similar correlation can be made in other continents.

There are probably also some human factors (besides the amount of forest and crop land already referred to) involved in the location of commercial sources of drugs. Of course, any such plants that may grow in sparsely settled or uncivilized regions, like the interior of South America and Africa, are likely to be overlooked unless they are very important (e.g., quinine). On the other hand, in some parts of the world most of the inhabitants are too intelligent and prosperous to spend much of their time in such relatively simple and unremunerative business as digging up roots. This may be another explanation of why so few of our drug plants come from the western half of the United States; for the western mountaineers are far more prosperous than the eastern ones.

There seem to be no statistics on the number of people in the United States whose main occupation is gathering medicinal plants, or the value of their harvest, but in the occupation table of the Mexican census of 1921, 186 persons are classed as diggers of roots, and 1812 as gatherers of chicle gum (in a population of 14,334,780). In this country probably most of the herb gatherers are farmers primarily, and they go out after drug plants only when farm work is not pressing.

If we interpret the tropics mathematically as that portion of the earth bounded by the Tropics of Cancer and Capricorn, 159 of the drug plants mapped by Dr. Newcomb come from the North Temperate zone, 59 from the tropics, and only 5 from the South Temperate zone. Only a few are common to temperate and tropical regions. Dividing them by continents and smaller divisions, we find that Canada has 17, eastern United States 88, western United States 14, Mexico and Central America 13, the West Indies 11, South America 24, Europe 69, western Asia 24, eastern Asia 40, Africa 29, and Australia and Polynesia 5. This grouping, of course, involves more duplication than the zonal one, for several species are common to different continents, or native in one and introduced or cultivated in another; and sometimes the same drug is obtained from two or more related species of plants which grow in different regions.

It is possible that a similar map prepared in some European country would show more drug plants in Europe and fewer in America, for the list of officinal plants varies in different countries, and each country naturally is partial to its own products. The number of recognized drug plants tends to decrease from one decade to another, however, with the substitution of synthetic products and surgical processes for the old herb medicines.

By size and other factors, the drug plants of temperate regions may be classed as follows:—Large trees 16, small trees 10, woody vines 2, shrubs 25, herbs 100, and cellular cryptogams 6. In the tropics 25 are trees (large or small), 5 woody vines, 11 shrubs, and 11 herbs, according to the best information at present available. Nearly all parts of plants are used, from roots to seeds.

An analysis of the chemical or therapeutic properties of all these drugs by zones, and countries would doubtless show some interesting contrasts, but would be a rather difficult matter, for many drugs have several different properties, some more important than others.

ROLAND M. HARPER.

ANNOUNCEMENT

THE series on the *Agricultural Regions of South America* by Dr. Clarence F. Jones is completed in this issue.

In the next issue Dr. O. E. Baker resumes his series on the *Agricultural Regions of North America*, and Dr. Griffith Taylor's series on the *Agricultural Regions of Australia* will begin.

Agricultural Regions of Africa, by Homer L. Shantz of the University of Illinois and president-elect of the University of Arizona; and *of Asia*, by Samuel Van Valkenburg of the College of the City of Detroit will follow in later issues to complete the finest geographic discussion of the world's agriculture thus far published.

To obtain the complete series of these extremely valuable articles, which present for the first time on such a comprehensive and accurate basis the significant divisions of the world's most important industry, it will be necessary to subscribe at once for ECONOMIC GEOGRAPHY, and date back to the October, 1926, issue.

In addition to this series of articles on agriculture, other series are being initiated; every issue will also contain four or five articles dealing with urban and regional geography, with problems of land utilization, with programs of development of resources, with commerce, with transportation, with health, and with the hundred and one other subjects that are of present geographic interest, all by the most competent and best informed authorities in their respective fields. ECONOMIC GEOGRAPHY is indispensable to the intelligent citizen.

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Only a limited number of the first numbers of ECONOMIC GEOGRAPHY are available.

The October issue of Volume 5 contains the following articles:

Geography's Part in the Plant Cost of Iron and Steel Production at Pittsburgh, Chicago, and Birmingham, Langdon White, Randolph-Macon Woman's College.
Readjustments in Post-War Cotton Culture, Earl C. Case, University of Cincinnati.
Tung Oil: Florida's Infant Industry, M. Ogden Phillips, Formerly, University of Florida.
The Farm Problem, Robert Stewart, University of Nevada.
Forest Regeneration in Porto Rico, William D. Durland, Formerly, University of Porto Rico.
The Topographic Map of the United States, Guy Elliott Mitchell, U. S. Geological Survey.
Agricultural Regions of South America, Clarence F. Jones, Clark University.

July includes:

Canada's Advance to Hudson Bay, Harold S. Patton, University of Cincinnati.
Economic Conditions in St. Vincent, B. W. I., G. Wright, Imperial College of Tropical Agriculture, Trinidad.
Economic Geography of the Hawaiian Islands, Otis W. Freeman, State Normal School, Cheney, Washington.
Agricultural Regions of South America, Clarence F. Jones, Clark University.
Iron and Steel Industry of the Cleveland District, John B. Appleton, University of Illinois.

April includes:

Agricultural Regions of South America, Clarence F. Jones, Clark University.
The Potash Industry of Europe, Fred S. Mohme, University of Illinois.
The Sugar Industry of the British West Indies and British Guiana with Special Reference to Trinidad, C. Y. Shephard, Imperial College of Tropical Agriculture.
Iron and Steel Industry of the Middlesbrough District, John W. Frey, University of Wisconsin.
The Grape Industry of Spain and Portugal, W. O. Blanchard, University of Illinois, and Elizabeth R. Blanchard.
The Philippine Lumber Industry, Luis J. Borja.

January includes:

Industrial China, H. F. James, Wharton School of Finance and Commerce.
Land Resource Inventory of Michigan, Carleton P. Barnes, Michigan Land Economic Survey.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.
Scranton's Industrial Integrity, Clifford M. Zierer, University of California at Los Angeles.
A Critical Situation in Two One-Crop Wheat Farming Districts in California, John W. Coulter, University of Hawaii.

The October issue of Volume 4 contains the following articles:

Fisheries of the South Atlantic and Gulf States, J. H. Matthews, Atlantic Coast Fisheries Company.
The Iron and Steel Industry of the Birmingham, Alabama, District, Langdon White, Randolph-Macon Woman's College.
America's Resources in Nitrogen, Potash and Phosphorus, Guy E. Mitchell, U. S. Geological Survey.
Possibilities of Rubber Production in Caribbean America, Jewell Venter, University of Missouri.
The Kentucky Geographical Surveys: A Review, W. Elmer Ekblaw, Clark University.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.

July includes:

The Civilizing Rails, Mark Jefferson, State Normal School, Ypsilanti, Michigan.
Piedmont North Carolina and Textile Production, Jefferson Bynum, University of North Carolina.
Location Factors in the Iron and Steel Industry, Richard Hartshorne, University of Minnesota.
The Ozark Orchard Center of Southern Illinois, Ina C. Robertson, State Teachers College, Valley City, North Dakota.
Agricultural Regions of South America, Clarence F. Jones, Clark University.
Egypt Is the Nile, Paul F. Gemmill, University of Pennsylvania.

Single copies of back numbers of Volumes 1 and 2, 1925 and 1926, will be sent to any American address for $1.75 each; to any foreign address for $2.00. Back numbers of Volume 3, 1927, Volume 4, 1928, and Volume 5, 1929, will be sent to any American address for $1.50 each; to any foreign address for $1.75. Whole volumes may be obtained at the yearly rate.

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CONOMIC GEOGRAPHY

APRIL

AGRICULTURAL REGIONS OF AUSTRALIA

Griffith Taylor, *Professor of Geography,* University of Chicago

CANE SUGAR PRODUCTION IN THE BRITISH EMPIRE

. J. Robertson, *Geographer,* St. Mary's Training College, Middlesex, England

RAINFALL AND WIND CONDITIONS RETARDING TROPICAL DEVELOPMENT

Stephen S. Visher, *Geographer,* Indiana University

AGRICULTURAL REGIONS OF NORTH AMERICA

iver E. Baker, *Senior Agricultural Economist,* U. S. Department of Agriculture

AND VALUES IN THE BLUE GRASS AND NASHVILLE BASINS

Raymond E. Murphy, *Geographer,* University of Wisconsin

RK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.

OUR CONTRIBUTORS

Dr. Taylor, professor of geography at the University of Chicago, contributes the first instalment of *Agricultural Regions of Australia,* a part of the series on the *Agricultural Regions of the World* published by ECONOMIC GEOGRAPHY. A geographer of note, he is familiar with various phases of geography of Australia. From 1920 to 1928 Dr. Taylor was head of the department of geography at the University of Sydney, and during 1927 and 1928 he was president of the Geographical Society of New South Wales. Dr. Taylor has written a great number of books on geography and related subjects, one of which, "Environment and Race," was reviewed in a previous issue of ECONOMIC GEOGRAPHY.

Dr. Robertson, who is lecturer in geography at St. Mary's Training College, Middlesex, England, graduated in natural sciences and in economics from the University of Edinburgh, and obtained his Ph.D. degree from the University of London. He is lecturer on the sugar trade at the City of London College.

Dr. Visher of Indiana University is the author of "Climatic Laws," "Tropical Cyclones of the Pacific," and co-author of "Climatic Changes." He has contributed articles on various aspects of tropical climates to *The Monthly Weather Review, Meteorological Magazine* (British), *Meteorologische Zeitschrift,* the *Bulletin of the American Meteorological Society,* and to the *Geographical Review.* He has carried on field studies in tropical regions.

Dr. Baker, senior agricultural economist with the U. S. Department of Agriculture, contributes Part VIII of the series of articles on the "Agricultural Regions of North America." He has been in charge of the preparation of the *Atlas of American Agriculture,* and in 1923 was chairman of the Yearbook Committee of the Department of Agriculture. He is the author of several agricultural bulletins, and joint author, with Dr. V. C. Finch, of the "Geography of the World's Agriculture." His publications relative to agricultural resources and their utilization have appeared in the agricultural yearbooks, in the *Annals of the Association of American Geographers,* in the *Geographical Review,* and ECONOMIC GEOGRAPHY.

Mr. Murphy, at present graduate assistant in the department of geography at the University of Wisconsin, received his M.S. degree in geology there in 1926, and is a candidate for the Doctorate in June, 1930. From 1926 to 1928 Mr. Murphy was instructor in the department of geology at the University of Kentucky. He is the author of "Recent Trends in Mineral Production" published in the *Journal of Geography,* November, 1928.

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AUSTRALIA

AUSTRALIA forms the antipodal frontier of white man's progress. A continent in area, an island in character and isolation, it constitutes a magnetic lure to imperial dreams and desires, to pristine adventure and achievement. It lies like a gem of colonial potentialities on England's brilliant crown of Pacific possessions, a gem still somewhat in the rough but of lustrous promise.

Australia bids fair to become the white man's continent its people wish it to be. None of the continents is so dominantly white, so deeply intent upon remaining so as is Australia, so well situated to keep the white blood pure. Dominantly agricultural and pastoral with few resources to make it industrial or commercial, it can retain its insularity of place and population, and leave its pioneer Anglo-Saxon peoples to perpetuate their blood untainted and uncolored, a nursery and reservoir of Nordic strength!

Aridity is Australia's widespread curse. Only a narrow coastal fringe of rain-blessed hills and watered plains borders the parched pasture lands and furnishes the fields and farms and orchard lands, so essential to the white man's granary and table. Relatively little of its continental expanse can ever be subdued and held in agricultural subjection, for the desert mallee and mulga scrub are incorrigibly rebellious, and have ever as irresistible allies the inadequate rainfall and subtropical temperature.

It is the desert that says nay to the ambitions of the Commonwealth, the dreams and desires of its settlers, the hopes of Britain that Australia shall homestead in the years to come hundreds of millions of her sons and daughters, a teeming people from coast to coast; "rather," say the desert and the sea "here shall we nourish and shelter between us, and save for the millenia to come, a fine, selected stock of sturdy, staunch British, pure in blood and undefiled.

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ECONOMIC GEOGRAPHY

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AGRICULTURAL REGIONS OF AUSTRALIA

INSTALMENT I

Griffith Taylor
Professor of Geography, University of Chicago

AMONG the seven continents, Australia fills a humble place not only from her small size, but to an even greater extent from her general environment. From the point of view of agriculture, she is a long way down the list of the world's chief countries. Thus as regards area of cropped land the following is approximately the order of importance of the continents. (The data are largely from Whitbeck and Finch.)

THE GENERAL ENVIRONMENT

It is impossible to obtain figures for the whole continent for Asia, South America, and Africa. However, the relation between population and crops is fairly well known for Asia, and from it one can make a rough estimate of the total area of cropped lands in Africa and South America where similar primitive conditions are found.

Continent	*Population* (Millions)	*Estimate of Cropped Land* (Million Acres)
Asia	870	800
Europe	500	570
North America	144	360
Africa	124	113 *
South America	65	68 *
Australia	6	16

* Estimated without definite information; none available.

In the following table the recorded and estimated areas are summarized, by millions of acres:

Asia	
China	400
India	300
Siberia	34
Japan	18
Java	8
Formosa	2
Total . . . . . Over	762

Europe	
Russia	250
Germany	65
France	60
Spain	40
Hungary	35
Italy	30
Austria	25
Roumania	15
Remainder	50
Total . . . . About	570

North America	
United States	300
Mexico	30
Canada	20
Cuba	1
Total . . . . . About	360

Africa	
Algeria	10 *
Egypt	7
Total	113 *

South America	
Argentine	47
Chile	3
Uruguay	2
Total	68*

Australia	
New South Wales	4½
Victoria	4½
South Australia	3
West Australia	2
Queensland	1
Total	16

* Estimated without definite information; none available.

Thus Australia agriculturally is at present only as important as a small country like Roumania. It is, however, because her cropped lands can be considerably extended and can everywhere be used more intensively that she merits considerable attention.

Among the continents Australia stands out in a number of ways. In addition to the small size, we must note the low level of most of the continent. Only about 5 per cent has an altitude exceeding 2,000 feet. The almost unbroken character of the coastline contrasts markedly with the "peninsular" character of most of the other continents. It has most affinities with North Africa both as regards topography and latitude, and like North Africa a large proportion of it is arid. The following table shows how the rainfall is distributed.

Annual Rainfall		*Under 20 inches*	*20–40 inches*	*Over 40 inches*
Australia	Largely hot	66%	22%	12%
Asia	Largely cool	67	18	15
Africa	Largely hot	54	18	28
North America	Largely cool	52	30	18
Europe	Largely cool	47	49	4
South America	Largely cool	16	8	76

This table explains why our agriculture covers so small an area, for unfortunately Australia is essentially the *hot* arid continent, just as Asia is the *cool* arid continent. In the south of Australia, however, much of our agriculture is carried on with rainfalls as low as 12 inches, so that this factor must be examined in detail; for total rainfall is only one of the many physical controls affecting agriculture (see Fig. 1).

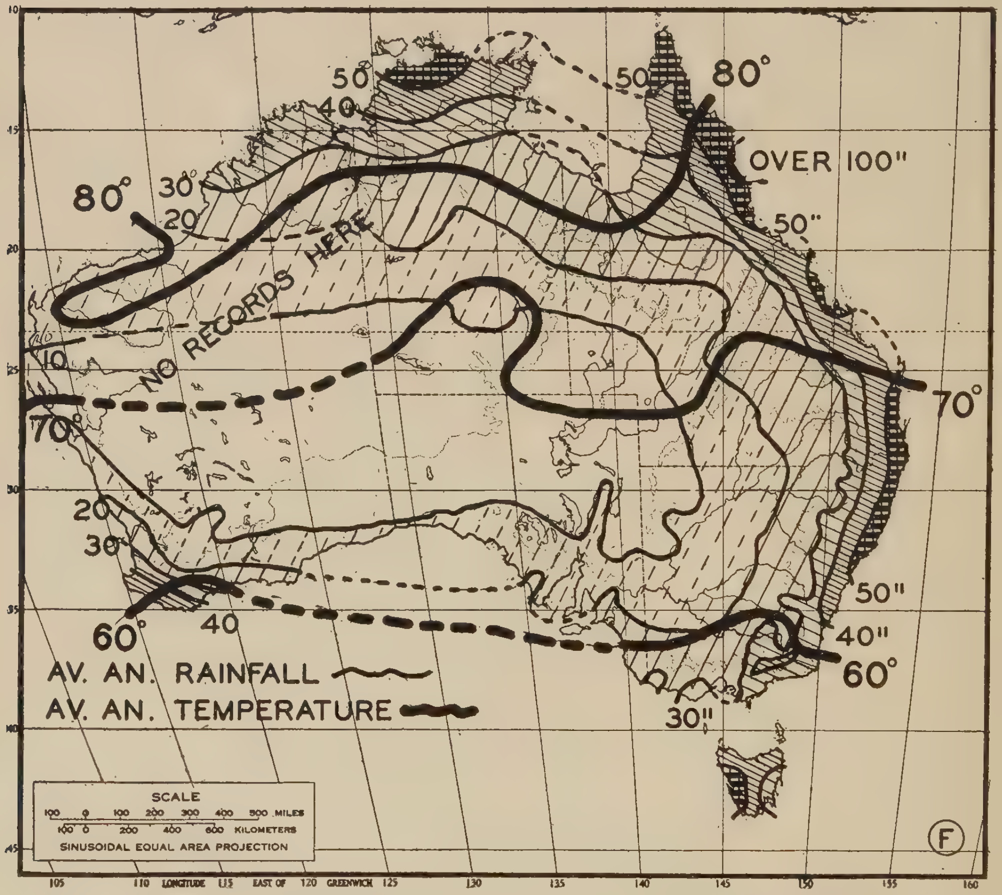
50
40
50
80°
OVER 100"
80°
30°
20
50"
NO RECORDS HERE
10
70°
70°
20
30
50"
40"
60°
60°
40
30"
AV. AN. RAINFALL
AV. AN. TEMPERATURE
SCALE
100 0 100 200 300 400 500 MILES
100 0 200 400 600 KILOMETERS
SINUSOIDAL EQUAL AREA PROJECTION
F
105 110 LONGITUDE 115 EAST OF 120 GREENWICH 125 130 135 140 145 150 155 160

FIGURE 1.—A composite map of the average annual rainfall and the average annual temperature of Australia.

RAINFALL RÉGIME

The continent may be divided into five fairly definite rainfall regions depending on the amount and season of the rain. A line extending from North-West Cape to Sydney separates the northern half with *summer rains* from the southern half with *winter rains*. This is the primary division. But, along much of the east coast there is a series of low-pressure systems which move southwards especially in autumn and give a good deal of rain. Furthermore, the steady onshore east winds (Trade Winds) of the northeast give a fairly uniform rain throughout the year along the northern half of the east coast.

In the interior of the continent neither the winter or summer rains are abundant, and here life has adapted itself to arid conditions

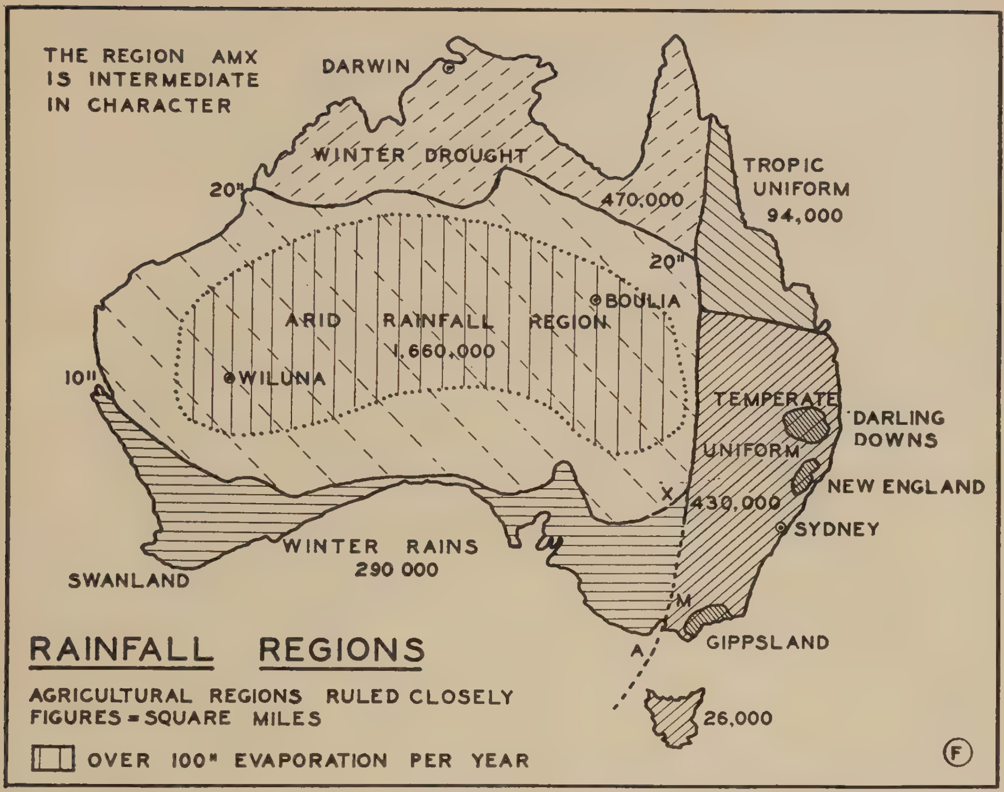
THE REGION AMX
IS INTERMEDIATE
IN CHARACTER
DARWIN
WINTER DROUGHT
20"
470,000
TROPIC
UNIFORM
94,000
20"
BOULIA
ARID RAINFALL REGION
1,660,000
WILUNA
10"
TEMPERATE
UNIFORM
430,000
DARLING
DOWNS
NEW ENGLAND
SYDNEY
X
WINTER RAINS
290 000
SWANLAND
M
GIPPSLAND
A
26,000
RAINFALL REGIONS
AGRICULTURAL REGIONS RULED CLOSELY
FIGURES = SQUARE MILES
OVER 100" EVAPORATION PER YEAR
F

FIGURE 2.—The rainfall regions of Australia as related to its agricultural possibilities. Much of the continent exhibits marked seasonality of rainfall.

whether the infrequent rains belong to the summer or winter season.

From a study of native vegetation and economic possibilities the writer has adopted the 20-inch isohyet (with 100 inches evaporation) as the northern boundary of the arid region, while the 10-inch isohyet (with 60 inches of evaporation) is the corresponding southern boundary. In the east the uniform-rain boundary passes through places where 8 months

Temperate Group	*Area in 1,000 Square Miles*	*District*	*Chief Products*
A. Uniform	456	Southeast Queensland East New South Wales East Victoria Tasmania	Timber, dairies, orchards, farming, sheep, wheat, maize (sugar in north).
B. Winter rains	290	Swanland (West Australia) Coast of South Australia	Timber, dairies, orchards, farming, sheep, vines, wheat.
C. Arid	1,660	Interior and Central West Coast of Australia	Cattle in north and more rugged and drier regions; sheep in south and east. (One-third of area is quite unoccupied.)
Tropical Group			
D. Eastern coast (uniform)	94	Central coastland of Queensland	Timber, dairies, sugar, small plantations of tropical products, cattle.
E. North (winter drought)	470	North Coast of Australia	Cattle.

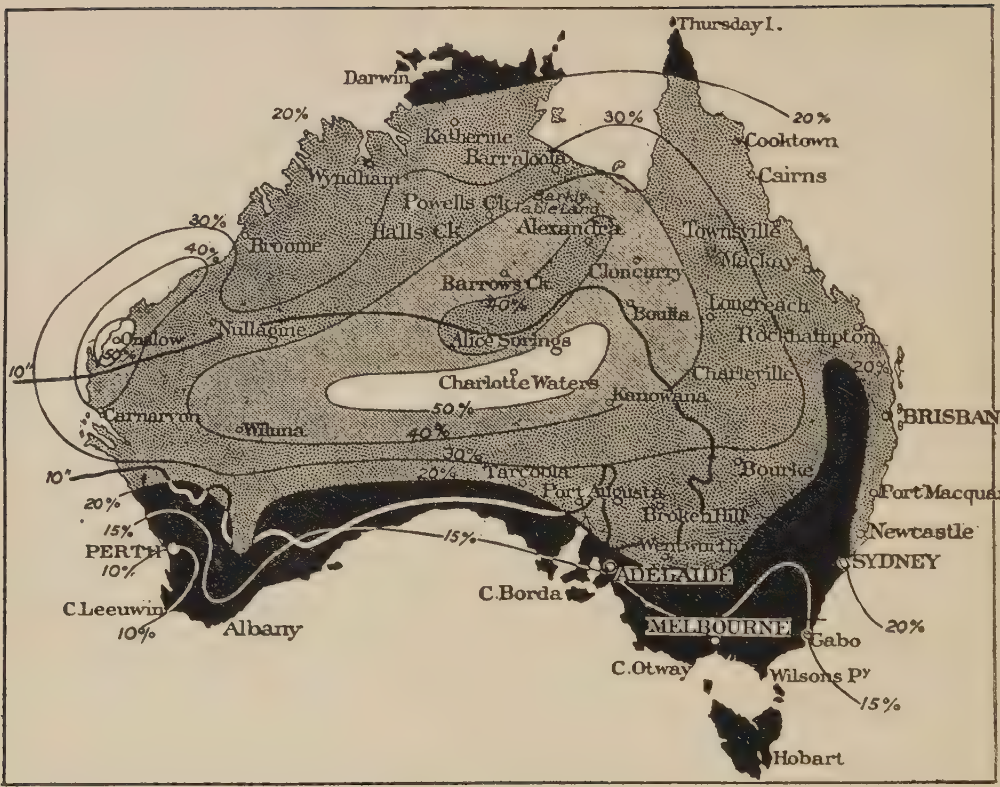
Thursday I.
Darwin
20%
Katherine
Barraloola
30%
20%
Cooktown
Cairns
Wyndham
Powells Ck
Barkly Tableland
Halls Ck
Alexandria
Townsville
30%
40%
Broome
Mackay
Cloncurry
Barrows Ck
40%
Boulia
Longreach
Rockhampton
Nullagine
Alice Springs
Onslow
50%
10"
Charlotte Waters
Charleville
20%
Kanowana
50%
Carnarvon
Wiluna
40%
BRISBANE
30%
20%
Tarcoola
Bourke
10"
20%
Port Augusta
Port Macquari
Broken Hill
15%
15%
Newcastle
PERTH
Wentworth
SYDNEY
10%
ADELAIDE
C.Borda
C.Leeuwin
MELBOURNE
Gabo
20%
10%
Albany
C.Otway
Wilsons Pʸ
15%
Hobart

FIGURE 3.—Rain reliability for Australia. Percentages show average deviation from the mean. Most reliable—black; least reliable—white.

in the year have over one inch of rain. In the west, owing largely to the off-shore winds, the arid region extends to the coast (see Fig. 2).

It is perhaps unnecessary to state that the preceding table (and map) (Fig. 1) refers primarily to agriculture. Other limits would be more useful if one were concerned directly with the pastoral industry—or with delimiting the desert areas.

We may now dwell on the character of the rainfall in these five regions before we consider the distribution of natural vegetation (see Fig. 2). Ignoring the east coast for a time, we see that the greater part of the continent exhibits a very marked seasonal rainfall. As the sun swings from the northern tropic (June) to the southern tropic (December) the belt of cyclonic storms swings in unison, but about a month later. Speaking generally, July is the wettest month along the south coast, for then the Antarctic belt of cyclones (*Lows*) is farthest north (in accord with the sun's swing). The two projecting areas of the south, Swanland (a short name for southwest Western Australia) and the coasts of South Australia receive good winter rains amounting to almost their whole annual precipitation. The heaviest rains occur close to the coast in Swanland and amount to 48 inches a year. In South Australia the heaviest are in the extreme southwest corner and only reach 33 inches (except for the top of the range near Adelaide which receives 47 inches). In West Victoria 78 inches is recorded near Cape

Otway. As Figure 1 shows, the rains rapidly fall off and the 10-inch isohyet runs fairly near the coast. The effect of the Antarctic *Lows* dies away inland and is hardly felt in the arid region north of the line joining North-West Cape to Sydney.

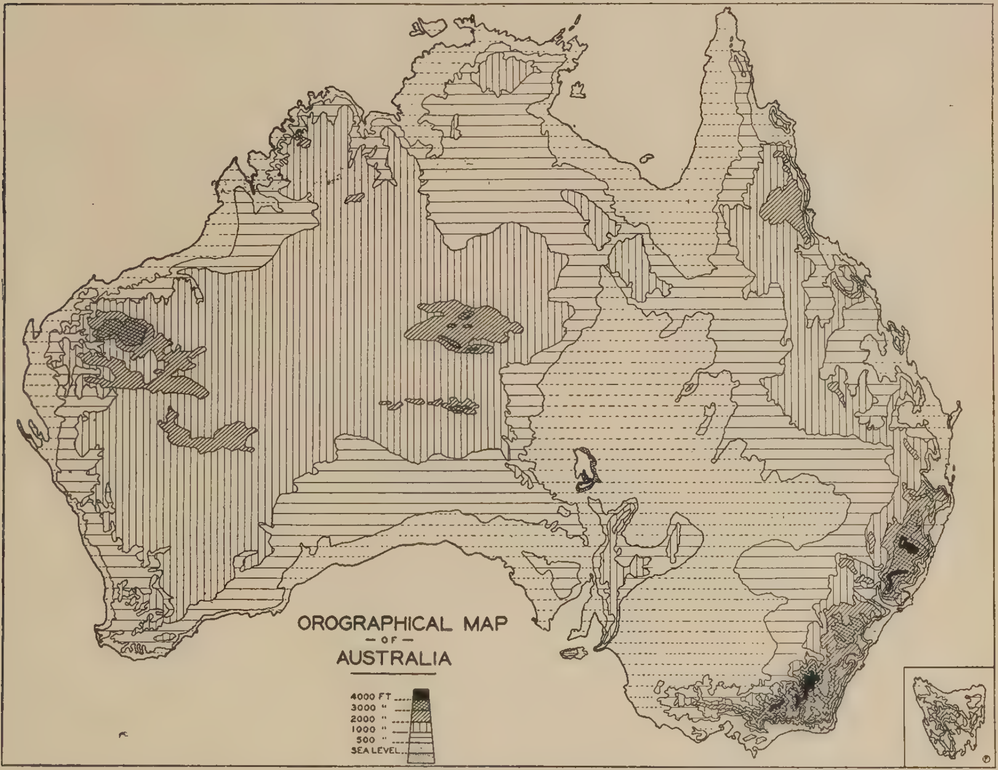

Figure 4.—Though most of the agricultural phenomena and distributions of Australia are controlled more or less directly by rainfall, the elevation, relief, and drainage of the continent locally cause most important and direct modifications of the normal climatic effects.

Turning now to the north coast of Australia we find a parallel state of affairs. Here, as the sun swings south, it may be pictured as dragging southwards the belt of Tropical *Lows* (or cyclones). They operate over North Australia during the months of December, January, and February, and give heavy rains during those months. But, there is practically no rain of note in the other nine months —and the characteristic feature of this large region is the nine months' drought. As a consequence the natural vegetation differs very little from that of the huge arid interior. It is almost wholly xerophytic except along the actual river banks and has no resemblance to the true jungles which occur along the east coast. Darwin is the wettest station with 60 inches, and 200 miles away the rainfall is 40 inches and soon drops to 20 inches as the map shows (see Fig. 1).

As regards the arid province as defined on the map, the characteristic feature of the country is the enormous evaporation. Along the central belt (from west to east) the annual evaporation is about 10 feet, while the rainfall is less than 10 *inches*. Boulia in West Queensland

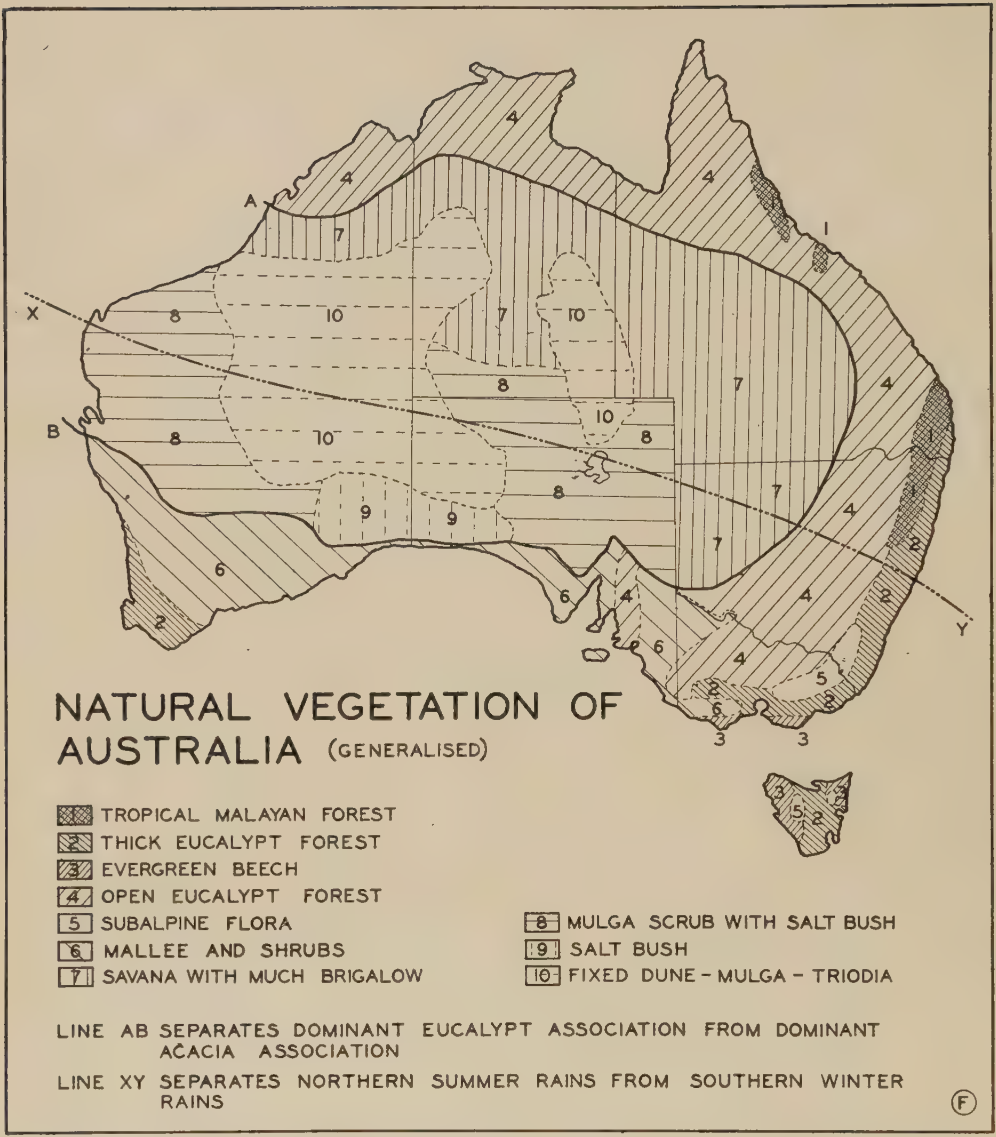
A
B
X
Y
NATURAL VEGETATION OF AUSTRALIA (GENERALISED)
1 TROPICAL MALAYAN FOREST
2 THICK EUCALYPT FOREST
3 EVERGREEN BEECH
4 OPEN EUCALYPT FOREST
5 SUBALPINE FLORA
6 MALLEE AND SHRUBS
7 SAVANA WITH MUCH BRIGALOW
8 MULGA SCRUB WITH SALT BUSH
9 SALT BUSH
10 FIXED DUNE - MULGA - TRIODIA
LINE AB SEPARATES DOMINANT EUCALYPT ASSOCIATION FROM DOMINANT ACACIA ASSOCIATION
LINE XY SEPARATES NORTHERN SUMMER RAINS FROM SOUTHERN WINTER RAINS
F

FIGURE 5.—A generalized delimitation of the natural vegetation regions of Australia as based upon the author's observations and Diels' map of 1906.

has an evaporation of 124 inches, and Wiluna in central West Australia has an evaporation of 153 inches. Thus, the region with over 100 inches evaporation a year nearly fills the area labelled "Arid Rainfall-Region." In addition to this the arid region has markedly *unreliable* rains, which deviate a great deal from the average. In nearly all the arid region the average variability is over 30 per cent.[1] This fluctuation is of course a tremendous handicap to stock owners, and makes agriculture an impossibility on any large scale (see Fig. 3).

We may now consider the two regions of fairly uniform rain. Obviously from what has been said there is a preponderance of summer rain to the north of Sydney, and of winter rain to the south of that city. But, all this eastern belt has over one inch of rain in 8 months of the year, while most of the temperate portion has over one inch of rain for 12 months of the year. Only a negligible amount (except in Tasmania and Gippsland, Victoria), however, has such a climate that the rainfall exceeds the evaporation. It is almost impossible to show it on a map of this scale, for it is a mere fringe along the coast.

---

[1] Thus, a place with an average rainfall per year of 20 inches and a variability of 30 per cent would be likely to have 14 inches one year and 27 inches the next.

In Tasmania the west coast lies in the path of the steady westerlies. Hence the western half of the island—which is mountainous—is so wet and bleak that it has no population except at the mines of the northwest (Fig. 1). The total rain exceeds 100 inches a year near Mount Lyell. In the highlands of Southeast Australia somewhat similar conditions are observed. The rainfall is over 60 inches and settlement is very sparse in the plateau areas.

In the northern portion of the Temperate Uniform area near Lismore the rainfall depends on proximity to the sea, rather than on elevation. A fringe along the coast some 10 or 20 miles wide has about 60 inches a year. On the New England Plateau (4,000 feet) the rains are lighter, only about 35 inches. But the temperatures are warm, and here is a good deal of farming and stock raising. Somewhat similar conditions with lower rainfalls are obtained in Southeast Queensland—and here the "downs" or upland country about 2,000 feet high is often good agricultural land (see Fig. 2).

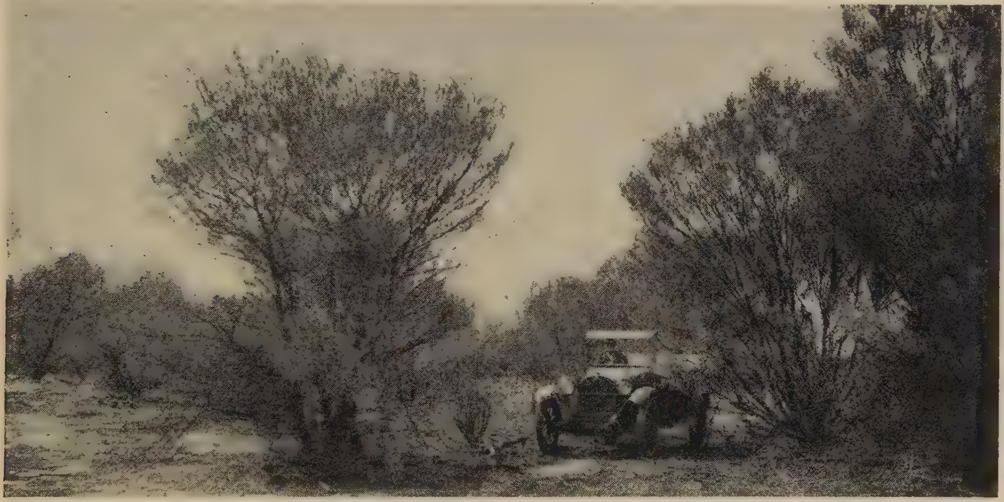

FIGURE 6.—Mulga (*Acacia aneura*), the commonest tree in arid Australia. Photo at Kingoonya—rainfall 8 inches—by the author.

NATURAL VEGETATION

There are unfortunately no vegetation maps in Australia, not even of the settled portions. Hence, any map must be only an approximation to the truth. Yet, nothing gives a better clue to the agricultural possibilities of a new country than the map of the natural vegetation. For years the writer has been urging the preparation of such a map (combined with an approximate soil map), but little has been accomplished to date. The writer has travelled through almost the whole of the continent, and the accompanying generalized map (Fig. 5) is based on his own experience and on Diels' approximate map of 1906.[2]

The salient division is that given by the heavy line *AB* which separates the dominant eucalypt flora from the dominant acacia flora. It is by no means a hard and fast line, but within this boundary the majority of the small trees are mulga, brigalow, or other of the many hundred species of acacia, while outside it in the wetter portions, the dominant trees consist of gums, ironbarks, boxes, stringy barks, and others of the three or four hundred species of eucalypt.

The next most important division is the line *XY* which approximately separates the northern (summer) rains from the southern (winter) rains. This does not greatly affect the dominant *tree* types, save that mulga (*A. aneura*) is the commonest acacia in the south, and Brigalow (*A. harpophylla*) is the commonest in the north. But, it seems to be the dominant control in the distribution of the natural forage growth. Thus, the Mitchell grass (*Astrebla*) association dominates in central Queensland, while the salt-bush (*Atriplex*) association dominates in the southern region. The salt-bush transgresses the seasonal rain line (*XY*) to a greater extent than does the grassland flora, but it does not reach far north of the MacDonnell Ranges.

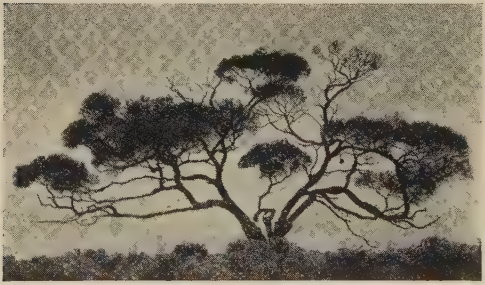

FIGURE 7.—A lone Myall, one of the acacias growing in arid South Australia. Photo taken at Kingoonya by the author.

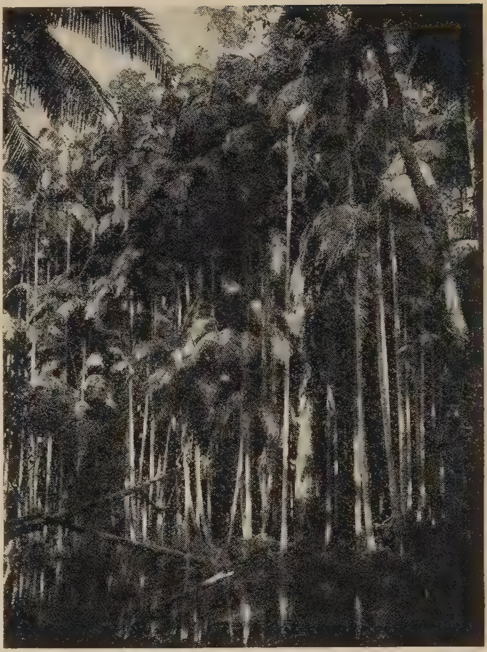

FIGURE 7a.—Bangalow palms (Archontophenix) characteristic of the tropical scrub now being cleared off to yield sugar-cane land in northeastern New South Wales, along the Clarence River. (Courtesy of New South Wales Govt.)

The largest remaining area consists of the huge regions of fixed dunes which cover about half a million square miles in the driest part of the continent. These dunes extend east and west for the most part. They are about 30 to 50 feet high, and 3 or 4 are crossed in a mile. They are "fixed" by a sparse growth of gums, mulgas, and above all by the so-called "Spinifex" (*Triodia irritans*), which is a sparse tussock grass growing in clumps up to ten feet across and several feet high. Thick belts of mulga occur in places, and ground-

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[2] Diel: *Pflanzenwelt von West Australien.* Leipzig, 1906.

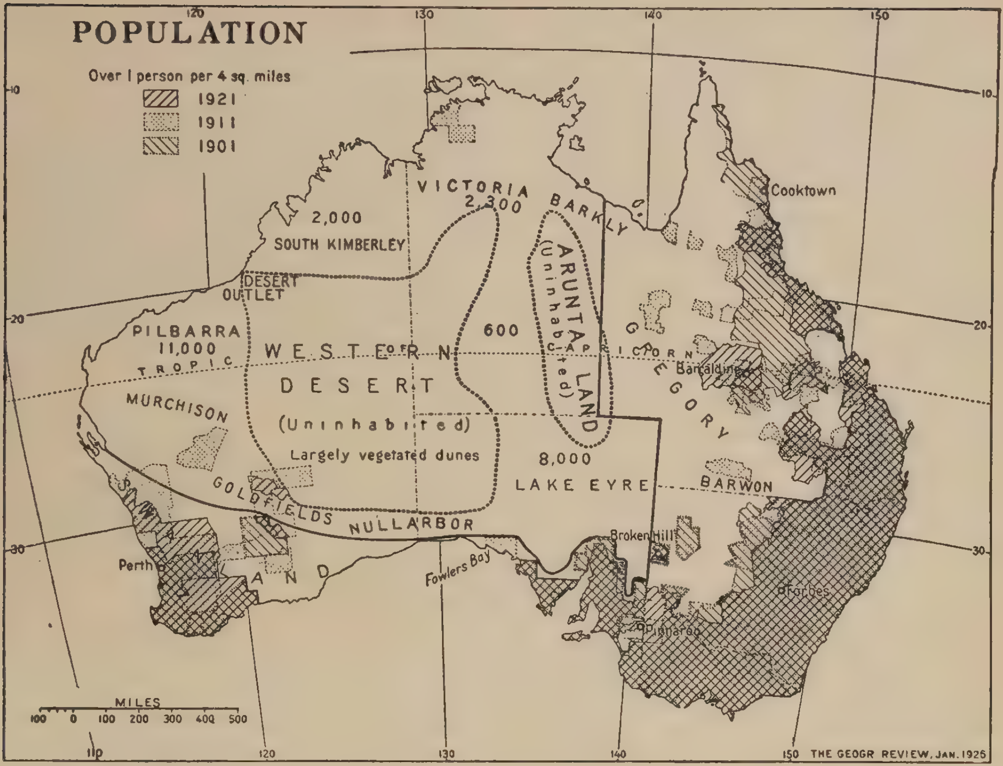
POPULATION
Over 1 person per 4 sq. miles
▨ 1921
1911
1901
120
130
140
150
10
20
30
VICTORIA
2,300
BARKLY
2,000
SOUTH KIMBERLEY
DESERT OUTLET
PILBARRA
11,000
TROPIC OF CAPRICORN
WESTERN
DESERT
(Uninhabited)
Largely vegetated dunes
600
ARUNTA LAND
(Uninhabited)
GREGORY
Barcaldine
Cooktown
MURCHISON
GOLDFIELDS
NULLARBOR
LAND
8,000
LAKE EYRE
BARWON
Broken Hill
Perth
Fowlers Bay
Forbes
Pinnaroo
MILES
100 0 100 200 300 400 500
110
THE GEOGR. REVIEW, JAN. 1926

FIGURE 8.—The distribution of population in Australia at the last three censuses. The dotted lines inclose areas without white population (Western Desert and Arunta Desert). The area north and west of the solid line enclosing 54 per cent of the total contains little more than one-third of 1 per cent of the population. The districts on the "frontiers of settlement" are named, and the approximate population is given in figures. Scale of map 1: 44,000,000. (Courtesy of the *Geographical Review*, 1926.)

water can often be found at about 50 feet. There is no white man or head of stock in the two areas labelled "Fixed Dunes" on the map. There are considerable areas of hamada (stony ranges) and serir (pebble-waste) in this vast region but the fixed dunes dominate throughout.

POPULATION[3]

The population of Australia, which numbered 5,435,732 in 1921, is spread very unevenly over the 2,974,581 square miles of surface. An area almost as large as the United States has a total population considerably less than that of New York City. The white settlement of Australia started at Sydney in 1788, and it is a matter of considerable geographical interest to see how it has spread through the continent in the course of 137 years. Unfortunately our census districts have varied greatly during the last few decades, so that it is almost impossible to obtain accurate population-variation charts. However, there are official maps showing the chief grades of population density for each decade, and one can learn much from a consideration of the three last censuses.

Let us take the grade of one person per four square miles (see Fig. 8).

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[3] In the discussion of population, the writer makes use of some paragraphs in his paper on "Frontiers of Settlement in Australia," published in the *American Geographical Review*, New York, Jan., 1926.

Comparing its boundary for 1911 with that for 1901, we find that in Queensland it runs much nearer the coast but that half a dozen "outliers" mark settlement in the interior. In New South Wales and South Australia the line is the same as in 1901 save for slight increase in the wheat belt in South Australia. In Western Australia a considerable expansion has taken place into the Murchison and Menzos goldfields.

The 1921 census almost everywhere shows no advance on the position of 1901. In Queensland the Barcaldine district has advanced; but elsewhere there would seem to be retreat. In New South Wales a slight retreat to the coast is apparent. In South Australia there is little change. In Western Australia there is an advance in the district northeast of Perth.

There has therefore been little addition to the population of the sparsely-settled regions ("sparselands" one may call them) in the past 20 years, in spite of a growth of one and a half millions in the total population of Australia. Official figures show the following distribution in 1921:

Six capital cities	2,338,079 = 43 per cent
Other towns	1,037,468 = 19.5 per cent
Rural population	2,030,422 = 37.5 per cent

One finds, however, that of this rural population some 94 per cent dwells in the reasonably settled areas near the towns and only about 6 per cent of the rural population dwells in the "sparselands."

The population map (Fig. 8) defines fairly accurately the limits of agriculture which correspond to the boundary of the "one person per square mile" area, except where there are large mines as at Kalgoorlie (in southern Western Australia), at Broken Hill (in western New South Wales), or in the rich sheep district of central Queensland.

Indeed, in most of the south of Australia the inner (dry) margin of the wheat belt is the limit of close settlement and thereafter the density of population drops to a very low figure indeed.

There is an impression in many circles in Australia that the *dry* interior is the chief *sheep* region of the Commonwealth. If one means *sheep per settler*, then this may be true, for little but sheep interests the population in these parts. But, if one means *sheep per square mile*, then the great sheep belt lies in the *wetter* areas or farmlands of Australia, and indeed the optimum belt for sheep is probably in wetter country than the optimum for wheat.

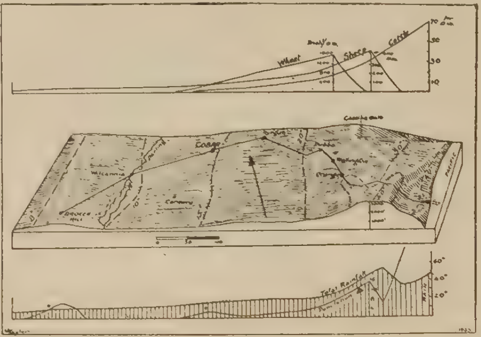

FIGURE 9.—The relation of climate to agriculture—particularly wheat, cattle, and sheep—is nowhere better illustrated than in Australia. Climatic controls along the Sydney-Broken Hill Route. The upper graphs show approximately the maximum densities per square mile for the counties in the various rain belts traversed. The block diagram shows the topography and the isohyets (annual). The lower graph shows the population density per county and the total rainfall.

Thus comparing the "densest belts" for cattle, sheep, and wheat in New South Wales, we find the following distribution. Cattle are most abundant on the coast, where the heavy rainfall ensures good permanent pasture for dairy cattle. The

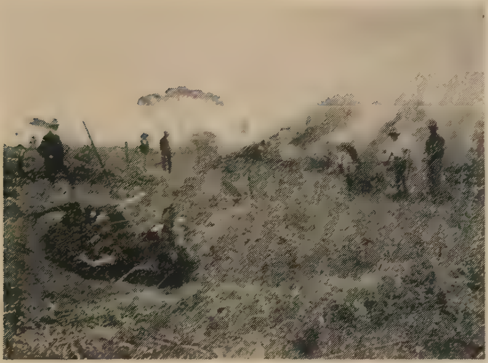

FIGURE 10.—Clearing the mallee at Berri in eastern South Australia, near the Murray River, by burning the brush, pulling the stumps, and removing the timber. (Courtesy of South Australian Govt. Photo Dept.)

cattle graph in the following figure (Fig. 9) is somewhat generalized (and better illustrates a traverse somewhat north of the route from Sydney to Broken Hill), but shows that the cattle in the region with less than 20 inches of rainfall a year form only an unimportant proportion of the whole.

The maximum belt for sheep is near Armidale (north of Cassilis) and receives about 33 inches of rain per year. Rainfall above that amount tends to produce foot-rot, while if it be too light, pasture is not reliable. On the map, the chief sheep belt extends from the top of the coastal divide to Nyngan. Many sheep are grazed in the drier regions (in the west of the State), but their density falls off rapidly to the west as the accompanying graph shows clearly.

As regards the wheat belt, on the whole it lies in somewhat drier country than the chief sheep belt. It extends from Orange southwards to Central Victoria though much grows on the margins of this optimum belt. There is very little wheat on the coast, which is too wet.

Finally, a few words may be said about the resulting distribution of population. The author has charted the densities of the counties passed through in the lowest graph. For Cumberland (*i.e.* around Sydney) the density was 430 per square mile at the last census (1911) available for that area.

The population falls off notably in the adjoining counties of Cook and Roxburgh. Here the barren sandstone soils and the deeply dissected topography of the Blue Plateau have counteracted the satisfactory rainfall. The populous counties around Orange are next traversed, with richer soils and more kindly topog-

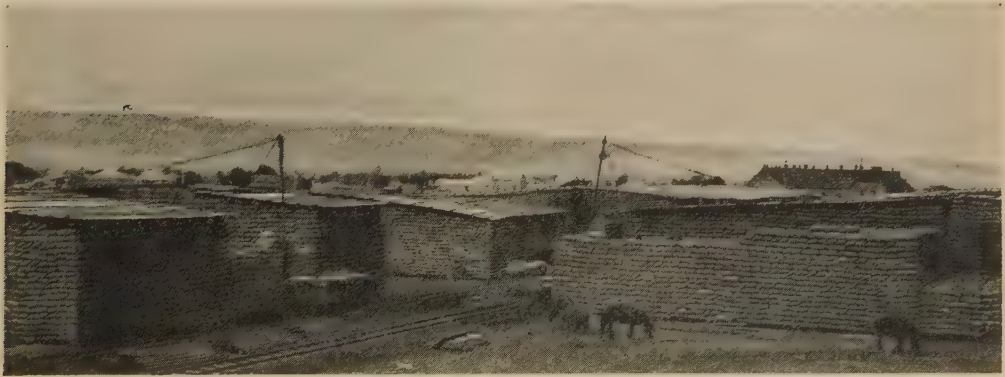

FIGURE 11.—Tens of thousands of sacks of wheat awaiting shipment from Port Pirie, South Australia. (Courtesy of South Australian Govt. Photo Dept.)

FIGURE 12.—Growing peanuts at the state experimental farm, near Warren, Queensland. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

raphy, though with somewhat lower rainfall. Thereafter, there is a steady falling off to negligible densities of population, except for the two mining townships of Cobar and Broken Hill. (Cobar had only 700 citizens in 1928.) Were it not for these two famous mineral centres the population of New South Wales would be almost negligible to the west of the 15-inch rainfall line, except in the Murray Valley.

AGRICULTURAL PRODUCTION [4]

The first settlers arrived in Sydney in 1788 under Captain Phillip and attempted to carry on British farming in an environment more closely resembling that of Carolina. The soil near Sydney is in general very poor, resulting from the weathering of Triassic sandstones (or somewhat inland, from shales). However, at Rosehill (10 miles from Sydney) 200 bushels of wheat and 60 of barley were harvested in December, 1789. About 40 miles to the west are extensive deposits of lake and flood silt along the Hawkesbury River, and here large crops of maize and lucerne are now grown, but the whole region is now known to be too wet for wheat. In 1813 the road over the deeply dissected Blue Plateau (4,000 feet) was discovered, and thereafter the drier western slopes were found to be excellently adapted to the growth of wheat.[5]

In 1850 about 198,000 acres were cultivated in New South Wales, 52,000 in Victoria, and 169,000 in Tasmania. The gold discoveries of 1851 withdrew the agricultural labor for a time, but soon led to a greatly increased demand for crops, so that by 1858 the land under crop in Australia totalled over one million acres.

The maximum area was cultivated in 1915–1916 as a result of a special war effort and reached 18½ million acres. In 1923–1924 it was 16½ million acres. Two noteworthy features stand out in the above table. Less than 1 per cent of the whole continent is cultivated—and yet, owing

FIGURE 13.—The grape harvest in the vineyards of Stanthorpe, Queensland. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

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[4] The chief authority for this section is the Commonwealth Year Book (edited by C. H. Wickens).

[5] See block diagram, p. 663, *American Geographical Review*, 1925.

Area Under Crop
(Thousand Acres)

Season Ending June 30	*New South Wales*	*Victoria*	*Queensland*	*South Australia*	*Western Australia*	*Tasmania*	*Total*
1880–1881	629	1,549	114	2,087	58	141	4,578
1900–1901	2,446	3,114	457	2,370	201	224	8,812
1920–1921	4,465	4,489	779	3,231	1,805	297	15,070
Percentage under crop, 1923–1924	2.4	8.3	0.2	1.5	0.37	1.7	0.87
Area per 1,000 people	2,177	2,881	1,075	6,789	6,566	1,274	2,875

to the small population, nearly three acres are cultivated for each unit of population.

Since the greater portion of the hay grown in Australia consists of wheaten or oaten hay, we see that the chief agriculture (80 per cent) is confined to wheat and oats.

	Acres
Wheat	9,540,000
Wheat hay	1,470,000
Oats	1,077,000
Oat hay	1,663,000
	13,750,000

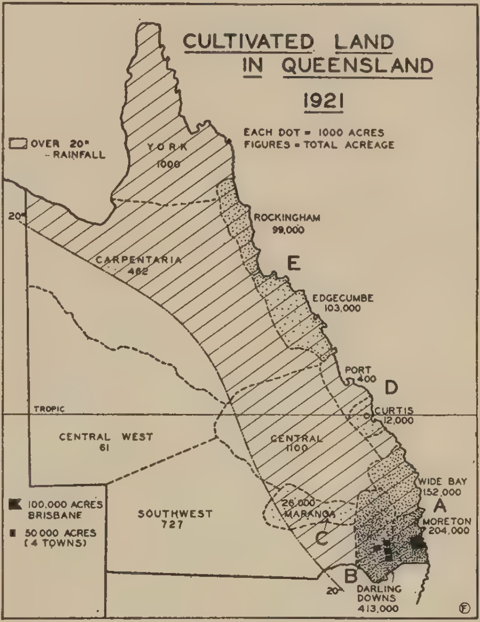
CULTIVATED LAND IN QUEENSLAND
1921
EACH DOT = 1000 ACRES
FIGURES = TOTAL ACREAGE
OVER 20" RAINFALL
YORK 1000
ROCKINGHAM 99,000
CARPENTARIA 462
E
EDGECUMBE 103,000
PORT 400
D
CURTIS 12,000
TROPIC
CENTRAL WEST 61
CENTRAL 1100
WIDE BAY 152,000
A
MORETON 204,000
26,000 MARANOA
C
100,000 ACRES BRISBANE
50 000 ACRES (4 TOWNS)
SOUTHWEST 727
B
20"
DARLING DOWNS 413,000
F

Figure 14.—The distribution of cultivated land in Queensland reflects the rainfall dominantly, the progress of settlement subordinately. The chief regions are distinguished on this map.

Relative Importance of Crops
(Thousands of Acres)

1923–1924	*New South Wales*	*Victoria*	*Queensland*	*South Australia*	*Western Australia*	*Tasmania*	*Australia*	*Per Cent*
Wheat	2,945	2,454	51	2,418	1,656	14	9,540	57.7
Hay	1,022	1,277	47	631	329	97	3,406	20.6
Oats	86	520	...	176	242	51	1,077	6.5
Green forage	430	107	307	55	52	10	961	5.8
Maize	167	29	120	...	...	..	316	1.9
Barley	4	56	...	184	8	4	256	1.6
Orchards	72	86	30	33	19	34	274	1.7
Sugar cane	17	...	220	...	...	..	237	1.4
Potatoes	22	59	6	5	5	37	134	0.8
Vineyards	14	42	1	49	5	..	111	0.7
Others	...	...	...	...	...	..	...	1.3

Tropical crops consist almost wholly of sugar, while warm temperate crops are represented by maize. But these two together only amount to 3½ per cent of the total. Considering the States in some detail we find that in New South Wales wheat (1), hay (2), green forage (1), and maize (1) are the four leading crops. In Victoria wheat (2), hay (1), oats (1), and green forage are the chief crops. In Queensland green forage (2), sugar (1), and maize (2) are the leading crops. In South Australia wheat (3), hay, barley (1) and oats rank first. In Western Australia wheat, hay, and oats (2) are noteworthy. (Figures represent order of importance among States.) In Tasmania hay, oats, and potatoes are the main crops.

DETAILED STATISTICAL INVESTIGATIONS

Since the agricultural regions of Australia are not yet adequately exploited, it is impossible to treat the subject so systematically as has been done in Europe or North America. Wheat is the sole crop which is so widely grown that it may be plotted as a definite "Wheat belt." Oats and barley are scattered more or less in districts near the capital towns. The potato crop is even less definitely distributed. Sugar is still scattered in plantations along the northeast coast.

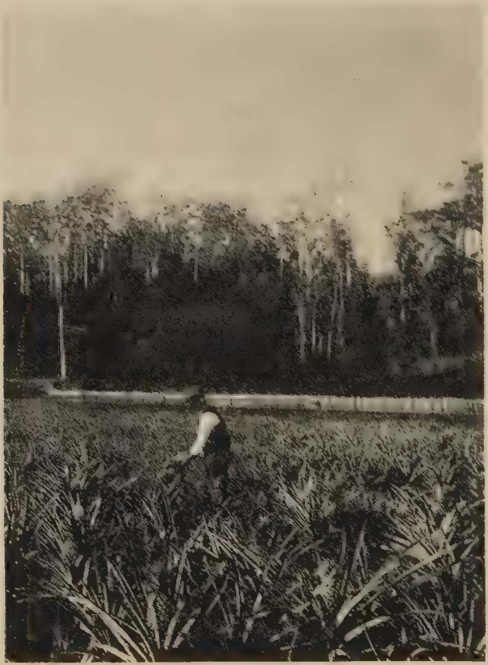

FIGURE 15.—A pineapple plantation, suggesting potential possibilities if adequate markets can be developed, at Woombye, near Gymple, southeast Queensland. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

For these reasons it has seemed preferable to study each State separately at first, and to give details of special crops or of special circumstances affecting crops in separate discussions later. Thus, the States will be considered in a statistical fashion, beginning with Queensland—the sole tropical State of any importance—and finishing with the vast State of Western Australia of which only about one-tenth at present has any prospects of agriculture.

AGRICULTURE IN QUEENSLAND

From the point of view of value the writer has taken the year 1921 as fairly representative, when the crops stood in the following order:

	Approximate Value, 1921	*Approximate Acres, 1921*
Sugar cane	£6,000,000	200,000
Wheat	1,000,000	175,000
Green forage	750,000	150,000
Maize	700,000	140,000
Lucerne	500,000	70,000
Bananas	400,000	10,000
Pineapples	170,000	4,000
Tomatoes	150,000	2,500
Oaten hay	130,000	13,000
Potatoes	120,000	10,000
Oranges	118,000	3,000
Wheaten hay	105,000	14,000
Remainder	357,000	13,000
Total	£10,500,000	804,000[6]

Thus, the crops listed represent 97 per cent of the state yield, and 98 per cent of the areas cultivated. (A new crop—cotton—was worth £287,000 in the year 1923.)

Let us now consider how these crops are distributed in the huge State of Queensland, which covers 420,000,000 acres.

DISTRICTS AND AREAS CULTIVATED

Agricultural Districts	*Towns*	*Areas Cultivated*
A. Moreton	Brisbane	204,000
Wide Bay	Maryborough	152,000
B. Darling Downs	Toowoomba	413,000
C. Maranoa	Roma	26,000
D. Port Curtis	Bundaberg, Rockhampton	12,000
E. Edgecumbe	Mackay	103,000
Rockingham	Townsville	99,000
Total for agricultural districts		1,009,000

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[6] About 200,000 acres of fallow land can be added to this area making the total for the state just over one million acres.

FIGURE 16.—Harvesting wheat in the Gooburra valley among the Darling Downs of Queensland. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

Non-Agricultural District:	Town:	Area: Cultivated
F. York Peninsula	Cooktown	1,000
Carpentaria	Cloncurry	462
Central West	Winton	61
Central	Emerald	1,100
Southwest	Charleville	727
Total for non-agricultural districts		3,350

If we now refer to the map where these areas and densities are plotted, it is readily seen that agriculture is only in its initial stages in Queensland. More than half of Queensland has over 20 inches of rainfall per annum, and probably a good deal of this huge area (especially in the east where the rain is more uniform) is suited for millet, ground nuts, and cotton. At present only the rich coastlands with more than 30 inches are utilized. There are, thus, five agricultural regions in Queensland (see Fig. 14).

A. *The Brisbane Region*, which extends north to Wide Bay and is continued in much the same country south to Grafton in the next State. Here grows market produce, sugar, maize, lucerne, and tropical fruits like bananas and pineapples.

B. *The Darling Downs*, where nearly all the wheat of the State is grown, and most of the lucerne. Here dairying, maize, cotton, and vines are also relatively important.

C. *Maranoa.* This region is much drier, and wheat is the only important crop. There is also a little maize, cotton, and vines.

D. *Central Queensland Coast.* Some sugar, maize, and tropical fruits are found here. This is also the chief cotton region in Australia.

E. *North Queensland Coast.* This is the chief sugar region. Dairying is increasing all along these coastal regions.

F. *Pastoral Regions* fill the rest of the State. However, millet and similar crops will in the future be grown in the wetter portions of the present pastoral area. In 1921 there were only 3,350 acres cultivated in all this western country. With few exceptions these insignificant patches are devoted to small vegetable and fruit gardens of purely local importance. Perhaps the only noteworthy exception is the growth of a little cotton and hay near Emerald.

AGRICULTURE IN NEW SOUTH WALES

The amount of cultivated land in this state is about 4¾ million acres. This is, however, distributed in a very irregular fashion through New South Wales. A table giving the areas in the 14 major land divisions will make this clear.

From the following table and the map (Fig. 17) it is obvious that the southern central portion of the State is

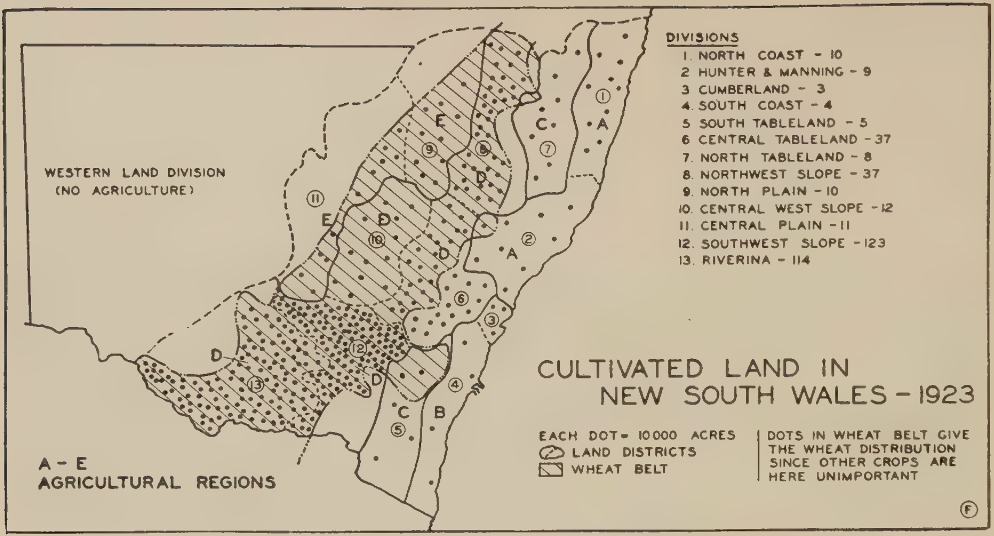
DIVISIONS
1. NORTH COAST - 10
2 HUNTER & MANNING - 9
3 CUMBERLAND - 3
4. SOUTH COAST - 4
5 SOUTH TABLELAND - 5
6 CENTRAL TABLELAND - 37
7. NORTH TABLELAND - 8
8. NORTHWEST SLOPE - 37
9. NORTH PLAIN - 10
10. CENTRAL WEST SLOPE - 12
11. CENTRAL PLAIN - 11
12. SOUTHWEST SLOPE - 123
13. RIVERINA - 114
WESTERN LAND DIVISION (NO AGRICULTURE)
CULTIVATED LAND IN NEW SOUTH WALES - 1923
EACH DOT = 10 000 ACRES
LAND DISTRICTS
WHEAT BELT
DOTS IN WHEAT BELT GIVE THE WHEAT DISTRIBUTION SINCE OTHER CROPS ARE HERE UNIMPORTANT
A - E AGRICULTURAL REGIONS
A
B
C
D
E
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
⑬
Ⓕ

FIGURE 17.—The distribution of cultivated land in New South Wales is closely dependent upon rainfall and topography. The chief regions are clearly presented.

by far the most important agriculturally. This includes the Riverina and Southwest Slopes of the State. The remainder of the Western Slopes rank next. The coast is not important except in the extreme north, and just around the Metropolis and Newcastle. There is practically no agriculture in the northwestern half of the State. The western boundary of wheat culture is shown on the map, and this is practically the limit of agriculture.

CULTIVATED LAND, 1923

Agricultural Region	*Division*	*Acres*	*Chief Crops* (Figures in thousands of acres)
A.	North Coast	101,000	Maize (53), Oats (11), Sugar (14), Bananas (4).
	Hunter and Manning	91,000	Maize (27), Oats (10), Lucerne (25).
B.	Cumberland	31,000	Fruit, etc. (12), Maize (4), Oats (4).
	South Coast	47,000	Maize (17), Oats (13).
C.	North Tableland	77,000	Oats (26), Maize (23), Wheat (12), Potatoes (9).
	South Tableland	48,000	Wheat (13), Oats (17), Lucerne (12).
D.	Central Tableland	370,000	Wheat (245), Oats (57), Lucerne (26), Maize (8), Potatoes (9).
	Northwest Slope	370,000	Wheat (327), Maize (22), Lucerne (13).
	Central West Slope	946,000	Wheat (926), Oats (10), Lucerne (8).
	Southwest Slope	1,230,000	Wheat (1,100), Oats (88), Maize (10), Fruit (7).
	Riverina	1,147,000	Wheat (1,033), Oats (80), Fruit (10).
E.	North Central Plain	100,000	Wheat (98).
	Central Plain	124,000	Wheat (122).
	East of Darling	5,000	No agriculture of note.
	West of Darling	1,000	
	Total	4,718,000	

We may, therefore, classify the State in the following five regions (see letters on Fig. 17):

A. *The Coast north of Newcastle*, where all the sugar, bananas, pineapples, nearly all the maize and much of the oats and lucerne grow.

B. *The Central and Southern Coast*, where fruit and some maize and oats are grown. Both A and B are largely devoted to dairying.

C. *The Northern and Southern Tablelands* are not important agricultural regions but oats and maize are a little more widely cultivated than wheat and potatoes.

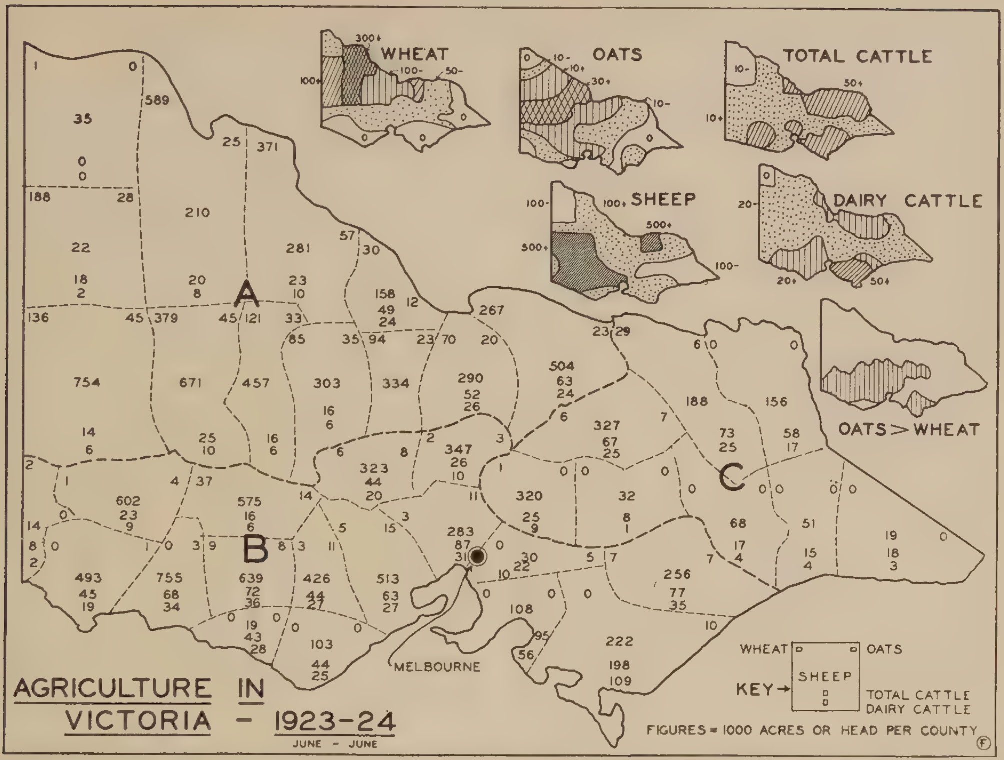
AGRICULTURE IN VICTORIA - 1923-24
JUNE - JUNE
WHEAT
OATS
TOTAL CATTLE
SHEEP
DAIRY CATTLE
OATS > WHEAT
A
B
C
MELBOURNE
KEY→
WHEAT
OATS
SHEEP
TOTAL CATTLE
DAIRY CATTLE
FIGURES = 1000 ACRES OR HEAD PER COUNTY

FIGURE 18.—A comprehensive graphic presentation of the status of agriculture in Victoria. The upper left hand figures refer to wheat, the upper right to oats, and the columns of three refer to sheep, total cattle, and dairy cattle from top to bottom.

D. *The Central Tableland and Western Slopes and Riverina* where wheat is by far the chief crop, but oats and lucerne are noteworthy.

E. *The Central Plains.* Only the eastern fringe of this region has any agriculture and here no other crop but wheat is important.

The following table gives the value of the principal crops in 1923:

Hay (wheat and oaten)	£8,884,000
Wheat	6,689,000
Maize	890,000
Green food	792,000
Fruit (except oranges)	732,000
Oranges, etc.	628,000
Market gardens	621,000
Sugar cane	348,000
Potatoes	319,000
Grapes, etc.	319,000
Oats	234,000
Tobacco	204,000

AGRICULTURAL REGIONS IN VICTORIA

This is almost the smallest state, occupying the southeast corner of the mainland. It is wholly in the temperate regions and resembles Portugal somewhat in its environment. The eastern portion consists largely of rugged plateau and the northwest of sandy heathlands, but the remainder is one of the chief agricultural areas in the Commonwealth.

The total area of the State is 56 million acres, of which 7 million are cultivated. An interesting table in the Victorian Year Book compares the agriculture of Great Britain and Victoria. These countries are almost the same size and not very different in environment.

	Victoria (Million)	*Great Britain* (Million)
Area (acres)	56	56
Wheat (bushels)	47	52
Oats (bushels)	9½	123
Barley (bushels)	1½	51
Potatoes (tons)	0.1	3½
Turnips, etc. (tons)	0.	26
Hay (tons)	1½	9
Horses (number)	½	7
Cattle	1½	7
Sheep	12½	22
Pigs	0.3	3½

Only in wheat and sheep is Victoria nearly as well developed. Britain is greatly in advance in oats, barley, and winter fodder like turnips. Winter feeding is, however, growing in importance in connection with dairying in Victoria.

The value of the principal crops in 1924–1925 was as follows:

	Millions
Wheat	£11.9
Hay	3.6
Oats	0.9
Potatoes	0.7
Barley	0.3

Wheat for grain represents about 54 per cent of all crops. About 90 per cent of the hay is oaten hay, which in Victoria is much more important than oats used as grain. We can thus divide the state into two main agricultural districts (Fig. 18): (A) the north and the northwest, where wheat is very much more important than oats, and (B) the south and center where oaten hay and oats together are much more important than wheat. The northeastern district, not so important, is characterized by almost equal importance of hay and wheat, with oats quite subordinate.

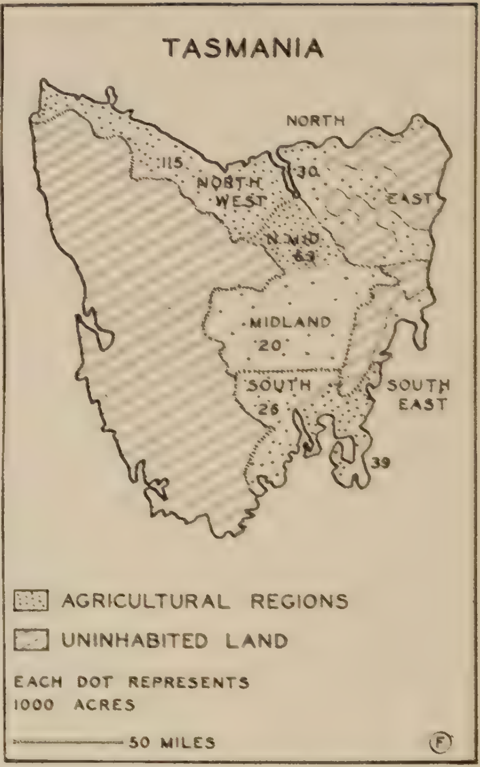

FIGURE 19.—A graphic summary of the agricultural land of Tasmania. Three major regions are portrayed—the North Coast, the Central Division, and the South Coast.

In region B, however, sheep and dairying are more important than pure agriculture. There is, of course, a great development of market gardens and orchards in the vicinity of Melbourne, with its 800,000 inhabitants. A little wheat is grown in the curiously dry rain-shadow areas right on the coast near Sale and Geelong. Maize and sugar beet are produced in Gippsland in small amounts.

GENERALIZED TABLE SHOWING CROPS GROWN IN DISTRICTS IN VICTORIA

District	Total Area (Million Acres)	Agricultural (1,000 Acres)	Pasture (Million Acres)	Unoccupied (Million Acres)	Chief Crops (Per Cent)
A. Wimmera	7.5	1,750	4.4	1.4	Wheat 70, Hay 19, Oats 10.
Mallee	11	2,384	3.5	5.2	Wheat 73, Hay 13, Oats 11.
Northern	6	1,550	3.4	1.1	Wheat 64, Hay 19, Oats 10.
B. Central	4	441	2.4	1.2	Hay 51, Gardens, etc., 24.
North-Central	3	145	2.2	.7	Hay 55, Oats 14, Wheat 13.
Western	8.5	367	6.2	2.0	Hay 52, Oats 21, Wheat 17.
Gippsland[7]	9	168	4.5	4.3	Hay, Barley, Maize.
C. Northeastern	7	172	3.6	3.3	Hay 37, Wheat 31, Oats 13.

AGRICULTURAL REGIONS IN TASMANIA

Only about 2 per cent of the cultivated land in the Commonwealth is found in Tasmania. Yet, the island State is of special interest, for here the driest portion is that most cultivated, and it is the *wet bleak* character of the west together with its rough topography which repels agriculture.

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[7] The three southeastern counties of Victoria are usually linked with Gippsland in the statistics. In Fig. 18, however, they are added to the rugged northeastern district.

In Figure 19 it is seen that the rugged country of the western half, and of portions of the east, still belong to the State. The agricultural portions are all in alienated land. The approximate boundaries of the land divisions (in the alienated land) are indicated.

The value of the crops in 1922–1923 was approximately as follows:

Potatoes	£880,000
Apples	776,000
Hay	652,000
Oats	314,016
Hops	226,000
Peas	157,000
Small fruits	144,000
Wheat	142,000

Hence, vegetables and fruit are more important in Tasmania than are grain crops. Oats is more than twice as important as wheat, while hops and peas are also more important.

We may divide the State into three not very different agricultural regions:

A. The North Coast, which is characterized by the potato crop, but grows large areas of oats, hay, peas, and apples.
B. The Central Division, which is chiefly oats with some wheat.
C. The South Coast, where fruit (largely apples and berries) is dominant, but a good deal of hay and grain is grown.

Tasmanian Crops in 1922–1923

District	*Area* (In millions of acres)	*Cultivated Acres*	*Chief Crops* (Figures in thousands of acres)
A. Northwest	3.2	115,000	Hay 39, Potatoes 27, Oats 25, Peas 11.
Northeast	2 7	31,000	Hay 12, Fruit 7, Oats 4, Potatoes 3.
B. North Middle	1 0	63,000	Oats 17, Wheat 10, Hay 21, Peas 7.
Midland	3 1	20,000	Oats 6, Hay 5, Wheat 2.
C. Southeast	1.3	40,000	Hay 19, Fruit 6, Wheat 6, Oats 4.
South	2 3	26,000	Fruit 17, Hay 3.
West	3 0	None	None

Agricultural Regions in South Australia

The amount of land under crops in this State (1923) was about 3½ million acres. No other State, save perhaps West Australia, shows such a sharp line of division between the closer settlement country and that used only for pastoral purposes. Indeed, the State is generally divided into two parts, the southern smaller moiety of 54 million acres which is divided up into 48 "counties," and a large moiety forming the remainder of the State ("outside the counties") which consist of 189 million acres. All the agricultural lands are in the counties (see Fig. 20).

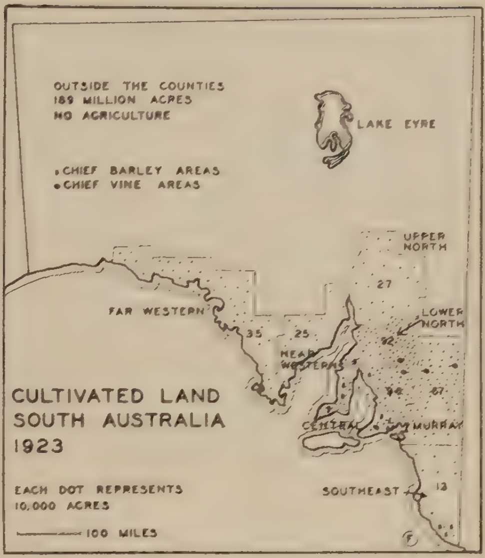

Figure 20.—The concentration of cultivated land in the coastal counties of South Australia is clearly indicated by this map. The main divisions are indicated and named.

We may, therefore, divide the agricultural lands (counties) of South Australia into five regions:

A. By far the most important is A, which surrounds the Gulf of St. Vincent. It includes

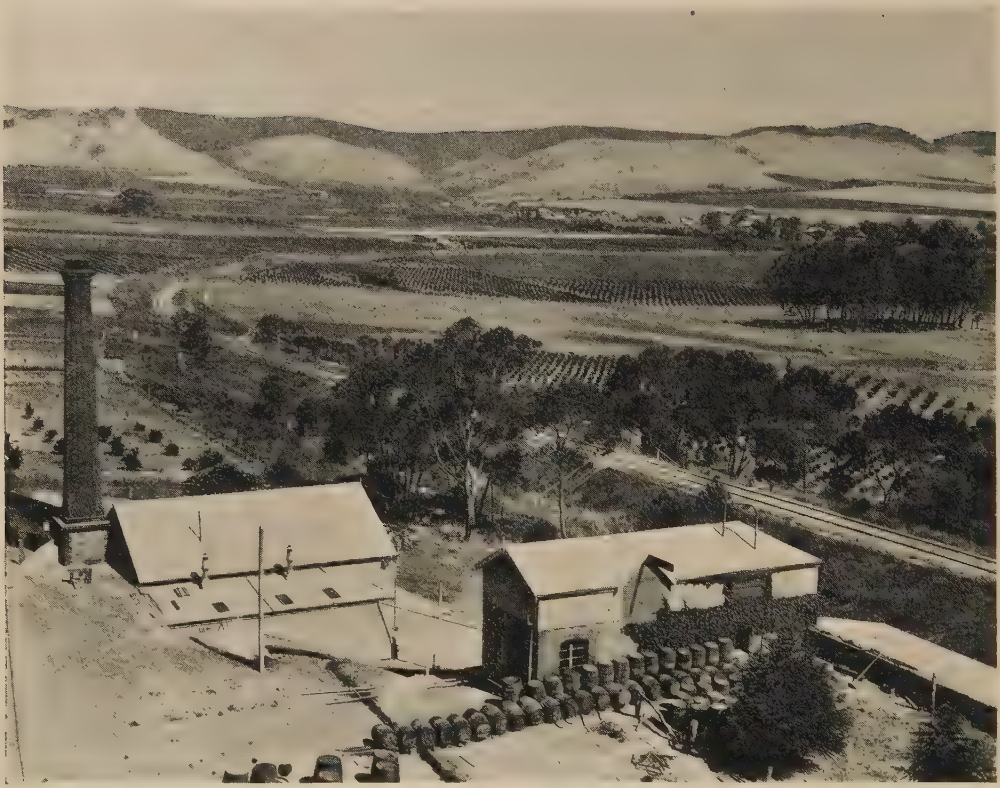

FIGURE 21.—A lovely landscape from the vineyard section about Tanunda, in hills north of Adelaide, South Australia. (Courtesy of South Australian Govt., Intelligence and Tourist Bureau.)

the Central and Lower North divisions. In this region nearly all the wheat, barley, and vines are grown, with much of the oats.

B. The Southeast Region grows much oats and some barley especially in the far south. Wheat is relatively less important.

C. The region along the Murray River where irrigation is practised is noteworthy. Here are important vineyards, while barley and wheat are grown to a large extent near the mouth of the river.

D. The Western Region is relatively important for oats and barley, but wheat is by far the chief crop.

E. The Upper North, where a small amount of wheat is grown.

CULTIVATED LANDS IN SOUTH AUSTRALIA

Agricultural Region	*Division*	*Area in Acres*	*Cultivated Acres*	*Chief Crops* (Figures in thousands of acres)
A.	Central	6,500,000	962,000	Wheat (497), Hay (220), Barley (140), Vines (27).
	Lower North	5,000,000	928,000	Wheat (215), Hay (138).
B.	Southeastern	6,000,000	136,000	Wheat (48), Barley (24), Hay (35).
C.	Murray	9,000,000	673,000	Wheat (483), Hay (87), Oats (65), Vines (14).
D.	Near Western	6,500,000	253,000	Wheat (481), Hay (50).
	Far Western	11,500,000	350,000	Oats (46).
E.	Upper North	9,000,000	272,000	Wheat (226), Hay (40).

The total area under crops was 3½ million acres, of which nearly 3 million were wheat and wheaten hay. The following table shows the value of the chief crops produced in South Australia in 1922–1923.

Wheat	£7,076,000
Wheaten hay	1,741,000
Vineyards	1,260,000
Oaten hay	797,000
Barley	681,000
Oats	287,000
Market garden	176,000
Potatoes	166,000
Oranges	164,000

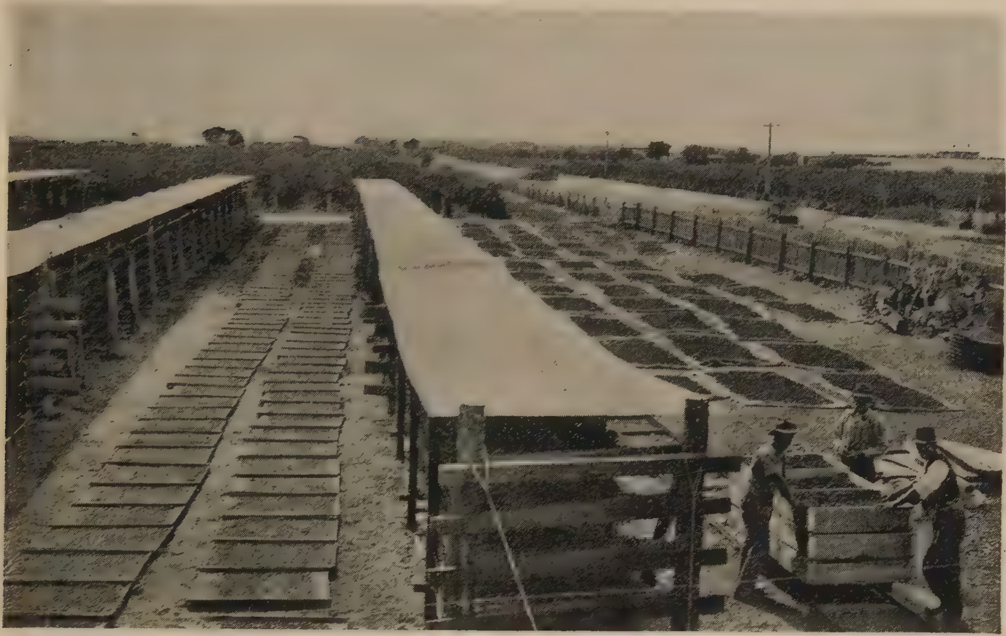

FIGURE 22.—Drying fruit in the sun at Renmark, at the extreme eastern end of South Australia near the Murray River. (Courtesy of South Australian Govt., Intelligence and Tourist Bureau.)

Lucerne	105,000
Dried fruits	104,000
Apples	102,000

AGRICULTURAL REGIONS IN WESTERN AUSTRALIA

This huge state contains almost one million square miles or one-third of the area of the whole Commonwealth. As far as agriculture and close settlement are concerned, only the southwest division is of importance—for here only is there a rainfall over 10 inches, with a temperate climate. This area (conveniently known as Swanland) is about 150,000 square miles, a little more than that of the British Isles (see Fig. 23).

In 1923, 10 million acres were alienated, almost wholly in Swanland, 262 million acres of pastoral lands were held under lease, and 335 million acres of the dry or tropical lands were unoccupied.

In this State wheat and oats constitute nearly the whole (97 per cent) of the crops as may be seen from the following table for 1922.

Crops	*Area in Acres*	*Percentage*
Wheat	1,336,000	70
Wheaten hay	222,000	12
Oats	163,000	9
Oaten Hay	113,000	6
Orchards	19,000	1
Green forage	27,000	1
Total	1,880,000	99

The wheat belt receives from 12 to 20 inches of rain and measures about 450 miles from north to south and 30 to 120 miles from west to east. The following notes describe agriculture in the newer wheatlands of Australia:

"Considerable areas of the poorer sand-plain, which are useless for growing wheat, occur in patches throughout the belt. The cost of clearing in this belt usually runs from 15 shillings to 30 shillings an acre. Usually the roots are left in the ground—where they finally decay. The ploughing is done with a stump-jump plough, which rises over obstructions—and greatly reduces the cost of production.

"Seedtime begins about April in the earlier maturing districts, and ends somewhere in

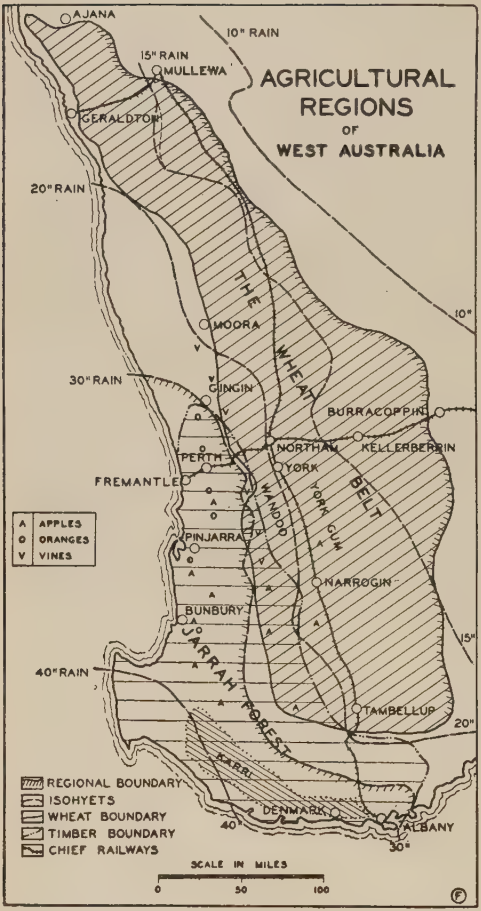
AGRICULTURAL REGIONS OF WEST AUSTRALIA
AJANA
10" RAIN
15" RAIN
MULLEWA
GERALDTON
20" RAIN
THE WHEAT BELT
MOORA
10"
30" RAIN
GINGIN
BURRACOPPIN
NORTHAM
KELLERBERRIN
PERTH
YORK
FREMANTLE
WANDOO
YORK GUM
A APPLES
O ORANGES
V VINES
PINJARRA
NARROGIN
BUNBURY
15"
JARRAH FOREST
40" RAIN
TAMBELLUP
20"
KARRI
REGIONAL BOUNDARY
ISOHYETS
WHEAT BOUNDARY
TIMBER BOUNDARY
CHIEF RAILWAYS
DENMARK
40"
ALBANY
30"
SCALE IN MILES
0
50
100

FIGURE 23.—The relationship between rainfall, natural vegetation, and agriculture is probably more clearly illustrated in West Australia than anywhere else in the world. The more humid agricultural section which has been designated "Swanland" has an area of 150,000 square miles, a little more than the British Isles.

June in the later districts. For fertilizers, phosphates are required but the soils usually contain enough nitrogen and potash.

"A typical farm consists of 1,000 acres and the farmer growing from 250 to 300 acres of wheat each year usually gets a crop every two or three years from a given area. Fallowing is managed as follows. The harvest is generally in December. The field is cleared in January and the farmer turns sheep on the stubbles. In May he seeds his next crop on another field previously prepared. He then ploughs the first field any time from June to September while the land is soft from the winter rains, and the weather is cool for his teams. In Spring he works over the surface with a disc harrow, etc., and so obtains a soil mulch. Such a fallow will store up from 3 to 6 inches of rain, and crops seeded in such land are practically independent of early rains. In 1923 the State had 977,000 acres fallowed in preparation for 1924."[8]

Few regions in the world exhibit rainfall controls so clearly—whether we consider the forest belts or the industries which are displacing them. The isohyets run parallel to the coast. Thus, from Perth round Cape Leeuwin to Albany is a strip 40 miles wide receiving more than 30 inches per annum. This was clothed with splendid eucalypt trees of three species—"Tuart" (*E. gomphocephala*) in the north, "Jarrah" (*E. marginata*) in the center, and "Karri" (*E. diversicolor*) in the south, especially where the rainfall increases to 40 inches. The next strip, from 30 to 25 inches, was mapped botanically by a continuous belt of Jarrah, and the next (25 to 20) still farther east by a belt of "Wandoo" (*E. redunca*). From 20 to 15 inches is the habitat of the York gum (*E. loxophlebla*). Here also are found specimens of Mallet, Salmon, and Gimlet gums, which are small trees, but invaluable for mining timbers. These latter grow throughout the drier portions of Swanland.

Karri and Jarrah have a world-wide reputation, and they are exported much more than any other Australian timber. They are greatly used for wood-blocks and piles.

The table on the following page shows concisely how man has adapted these vegetation belts to his needs.

SPECIAL CONDITIONS AFFECTING AGRICULTURE

In a vast new land like Australia where the population is very small,

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[8] From notes on wheat by J. W. Paterson in a Government publication.

FIGURE 24.—Jarrah trees, one of the eucalyptus group, the best timber tree in Australia, in the Pemberton district of West Australia. (Courtesy of West Australian Govt.)

the amount of literature bearing directly upon the physical controls governing agriculture is extremely scanty. There are active departments of agriculture controlled by the States and also allied bodies in the universities. But here also the geographical aspect has perforce been neglected. The writer has therefore been compelled to choose certain salient topics, which are far from being exhaustive of the subject, and which, moreover, are in some cases based on conditions found only in one State.

The Great Artesian Basin is of paramount importance in the pastoral lands of Queensland and is first described (Fig. 26). Because of the chief highlands much land in the *humid southeast* is of little use for agriculture. This is the next problem to be treated. Only in New South Wales has anything approaching a soil survey been made; thus, this important topic is only briefly discussed. Irrigation can only occur where permanent rivers flow, and only in the southeast of Australia do these conditions occur in inland areas. The two chief regions are described in some detail. Finally, no geographical discussion of our agricultural pests has heretofore appeared, so that no apology need be made for this preliminary account of the spread of rabbits and other pests.

GREAT ARTESIAN BASIN

Perhaps in only two salient features does Australia stand out in the agricultural world—in her wool production, and in the size of her main artesian basin. The two are rather closely linked together. Thus, in

Region	*Rainfall*	*Vegetation Belts*	*Crop*	*Towns and Mean Monthly Temperature*
A	Over 30 inches Warmer moiety	Tuart and Jarrah	Dairies Vines Oranges Sheep	Perth (January, 74°; July, 55°). Pinjarra.
	Over 30 inches Cooler moiety	Jarrah Karri	Dairies Apples Sheep	Bunbury, Denmark. Albany (January, 66°; July, 53°).
B.	30–20 inches	Jarrah	Vines, some wheat, farms	Gingin.
	20–15 inches	Wandoo York Gum	Great Wheat Belt	Moora, Northam, York, Narrogin (January, 72°; July, 50°).
	15–12 inches	York Gum	Dry Wheat Belt Sheep	Kellerberrin (January, 77°; July, 50°).
C.	12–8 inches	Mallet Gum Gimlet Gum Salmon Gum	Few sheep and Cattle	Carnarvon (80°, 61°), Yalgoo, Southern Cross, Kalgoorlie (77°, 51°).

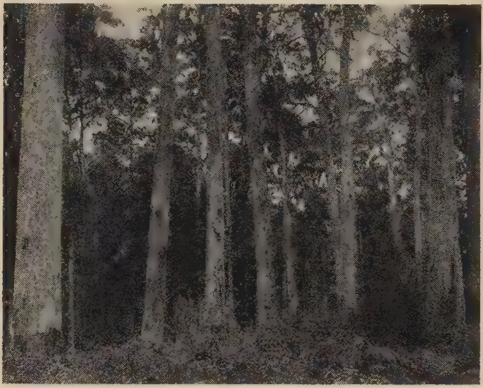

FIGURE 25.—A karri grove in the wet southwest section of West Australia. The karri trees, said to be the tallest trees in the world, even rivalling the giant sequoias of California, furnish excellent timber. (Courtesy of West Australian Govt.)

1880, Queensland had about 10 million head of stock. Bad drought years followed; yet by 1913 there were 28 million. This increase was due largely to the greatly improved water supply derived from the artesian sources.

In 1885 bores were begun in southern Queensland and water was struck at Thuroolgoona (near Cunnamulla) in 1887. The following bores were completed in 1923.

State	*Bores*
New South Wales	510
Queensland	2,968
South Australia	143
Northern Territory	167
Victoria	347
West Australia	209

Of this total of 4,344 bores, almost all in the first four divisions are in the Great Artesian Basin. (There are smaller basins which supply Victoria, West Australia, and parts of South Australia and New South Wales.)

The Great Basin covers about 600,000 square miles. The deepest water-supply is near the Barcoo River, where it was struck at 7,000 feet. For most of the basin the intake appears to be along the east Queensland highlands, whence the water slowly moves to the southwest. It finally appears at the surface in a series of mound springs which extend all along the margin of the basin in South Australia, especially south and west of Lake Eyre.

In general the temperature of the water increases towards the west; the gradient being 1° increase for 70 feet of depth in the east and about 1° increase for 20 feet in the west. The salinity also increases on the whole towards the outlet, being under 10 grains per gallon in the east and southeast, and over 20 grains per gallon in the west. The chief salt is sodium carbonate and the amount present does not harm stock. (These variations in heat and salinity are not very regular.)

About half of the bores in Queensland are flowing. In the others the water has to be pumped. The average flow of the flowing bores is about one-quarter of a million gallons per day. There is, unfortunately, a general decrease in the water supply of 3 per cent or more per annum. In Queensland 124 bores showed a diminution of 40 per cent in 15 years.

The chief sheep district of Queensland runs from Winton via Longreach to Charleville, that is, right through the middle of the Artesian Area. The bore water flows from the pipes into drains ploughed across the country. These are about a foot across and 10 inches deep. They often lead to dry creek-beds and convert them into small streams, thus giving permanent water to large areas where it was before non-existent. Some of these drains are 20 miles long. Although the water is often used for small gardens attached to "head stations," it has

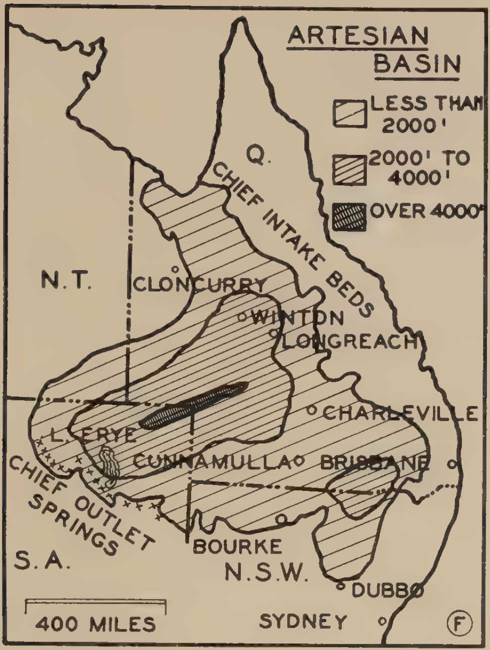

Figure 26.—The great artesian basin of eastern Australia just west of the height of land. Its importance to the pastoralist in this section can hardly be overestimated, particularly to sheep-grazing. It is one of the distinctive agricultural features of the continent.

not been found possible to use it for agriculture on a larger scale.

RUGGED AREAS IN SOUTHEAST AUSTRALIA

It is unfortunate for Australia that so much of her best watered land in the East is a region of recently uplifted fault-blocks. As a result the topography is rugged, and this is a notable factor in determining the utilization of the land. It is often difficult to decide why a region in a comparatively newly settled country like Australia remains empty. The haphazard observer declares that given time all will be well; the scientist often deduces that it is due to the inherent poor quality of the region. There are many folk in Australia who are readily satisfied that the Scottish Highlands are empty because of their poor resources, and yet these same folk will not admit that Australia has many large areas as little attractive to the settler and, therefore, never likely to be inhabited to any notable degree.

The accompanying map (Fig. 28) is an attempt to estimate the area of the least attractive portions in the wetter farming belt of New South Wales. The annual isohyet of 25 inches is shown, and a considerable proportion of this wetter area of about 78,000 square miles is still almost as empty as in the time of Captain Cook. (The basis of the chart is a large map showing every post office. There is hardly a settlement in this part of the State without a post office within six miles, and this is the criterion used.)

The New England Plateau of three or four thousand feet is deeply trenched on its seaward face by canyons up to 2,500 feet deep. As a result while the gentler western slopes are fairly settled, the east, except near Armidale, is nearly empty. The two elevated areas to the west are volcanic ranges with very rugged country.

Figure 27.—A panorama of the Burrinjuck reservoir, one of the principal irrigation projects in New South Wales. (Courtesy of New South Wales Govt.)

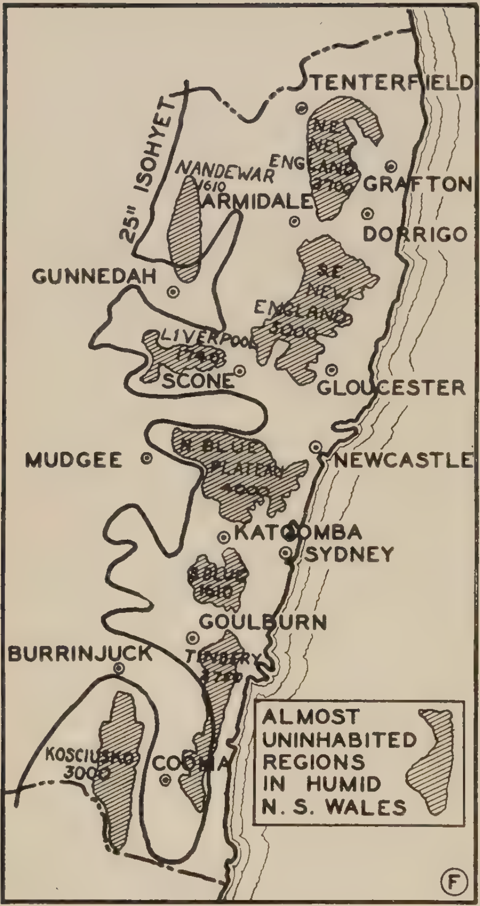
TENTERFIELD
25" ISOHYET
NANDEWAR 1610
NE NEW ENGLAND 3700
GRAFTON
ARMIDALE
DORRIGO
GUNNEDAH
SE NEW ENGLAND 5000
LIVERPOOL 1740
SCONE
GLOUCESTER
MUDGEE
N BLUE PLATEAU 4000
NEWCASTLE
KATOOMBA
SYDNEY
S BLUE 1610
GOULBURN
BURRINJUCK
TINDERY 2750
KOSCIUSKO 3000
COOMA
ALMOST UNINHABITED REGIONS IN HUMID N. S. WALES
F

FIGURE 28.—The least attractive portions of the wetter farming belt of New South Wales are indicated in this map. They represent areas of least favorable relief, soils, and drainage.

The Blue Plateau is built of barren sandstone dissected by wide canyons 2,000 feet deep—but a dozen tourist resorts (near Katoomba) growing up behind the metropolis have cut across this rugged area. In the south Kosciusko (7,328 feet) is a fault-block pushed up 5,000 feet above the general level and very bleak and wet. The Tindery region is probably a plateau scarp akin to that along the east of New England Plateau. Tabulating these areas, one finds

	Approximate Area (Square miles)
Northeast New England	3,700
Southeast New England	5,000
Nandewar Volcanics	1,610
Liverpool Volcanics	1,740
Northern Blue Plateau	4,000
Southern Blue Plateau	1,610
Tindery Scarp	2,750
Kosciusko Plateau	3,000
Total	23,410

Thus, about 30 per cent of the well-watered littoral of New South Wales has not yet been found suitable for notable settlement.

In Victoria only the east center is so rugged. An approximate calculation gives about 13,800 square miles for that part in the Victorian Highlands which is practically uninhabited. Here, also, the rainfall is over 25 inches per annum, and about one-third of such well-watered country in Victoria (as in New South Wales) is so far largely unused.

(Note.— Instalment II will appear in the next issue.)

CANE-SUGAR PRODUCTION IN THE BRITISH EMPIRE

C. J. Robertson
Geographer, St. Mary's Training College, Middlesex, England

THE trend of the world's sugar production is steadily upwards, the total having risen from 17.2 million tons on the average of the five pre-war years (1909–1910 to 1913–1914) to 27.2 million in 1928–1929. The increase was almost entirely due to cane sugar, the production of which had risen by 80 per cent, while that of beet sugar had risen by only 4½ per cent. As in production generally, the advance in this period has thus been almost entirely in countries outside Europe. The War and its aftermath of revolution affected particularly severely the European countries that produce beet sugar. Even before the War, Cuba's export surplus had reached the same level as that of Europe—about 2.5 million tons—and Europe's post-war deficiency was Cuba's opportunity, with the result that it has become the leading producer and dominates the open markets of the world. Increase of output occurred, however, at the same time throughout the countries producing cane sugar, and British producers shared in the boom that culminated in 1920. The capacity of the cane-growing regions to respond to the demand proved more than sufficient, and with the revival of European output there has followed a period of overproduction, relative, however, only to the world's present rate of consumption, which is still, owing to the War, below what would have been normal. The resulting period of low prices has led sugar producers throughout the world to seek stability in closer organisation, national and international. This has been one stimulus to the present movement among British producers towards strengthening their position.

GREAT BRITAIN'S SUGAR SUPPLY

Excluding British India, Great Britain comes second in the total quantity of sugar consumed only to the United States, its consumption in 1925–1928 being 30 per cent that of America. While, however, American consumption has in recent years increased continuously, that of Great Britain has not yet recovered from the setback received during and immediately after the War. During the War a committee of the Royal Society studied the calorific value of the country's food imports. Calculating on the basis of their statistics, sugar (excluding that used in brewing) made up 13.4 per cent of the total calorific value consumed in the United Kingdom in the period 1909–1913, taken as normal. The following table shows the change that has taken place since then in the source of the raw sugar imported.

IMPORT OF RAW SUGAR INTO GREAT BRITAIN *

1909–1913	*Per Cent*	*1923–1927* †	*Per Cent*
Germany	36	Cuba	35
Java	12	Mauritius	14
Austria-Hungary	11	Peru	9
Cuba	9	Santo Domingo	9
British West Indies (including British Guiana)	6	British West Indies (including British Guiana)	8
Mauritius	4	Java	6

* Accounts relating to the trade and navigation of the United Kingdom.

† From 1923 onwards British statistics exclude the Irish Free State.

As for refined sugar, Germany and Austria-Hungary supplied 41 per cent and 21 per cent in the pre-war period, while in the post-war period Czechoslovakia supplied 34 per cent, the Netherlands 30 per cent, the United States 14 per cent, and Canada 10 per cent.

The danger of dependence on Europe in time of war for supplies of raw or refined sugar became one of the arguments of those who wished to encourage production in British possessions overseas. To discuss the validity of this argument is outside the scope of this article.

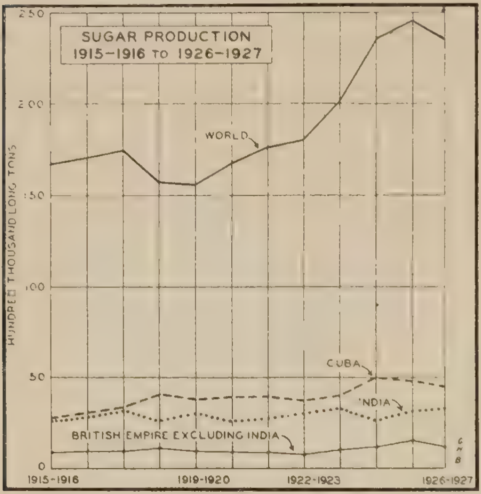

FIGURE 1.—How little of the sugar production of the world comes from the vast possessions of the British Commonwealth of Nations is strikingly revealed by this chart. (Sources: *Statistical Abstract for British Empire; World*, Willett and Gray; Cuba, *Facts about Sugar*.)

Preference for Empire sugar had been urged on behalf of the producers by an organised body since 1916, when there was formed a section of the British Empire Producers' Organisation devoted entirely to the encouragement of sugar production within the Empire. This body has since grown into the Sugar Federation of the British Empire, formed in 1927, of which the main objects are "to increase and improve production in the British Empire and secure for producers terms in all Empire markets at least as favourable as those accorded by foreign countries to

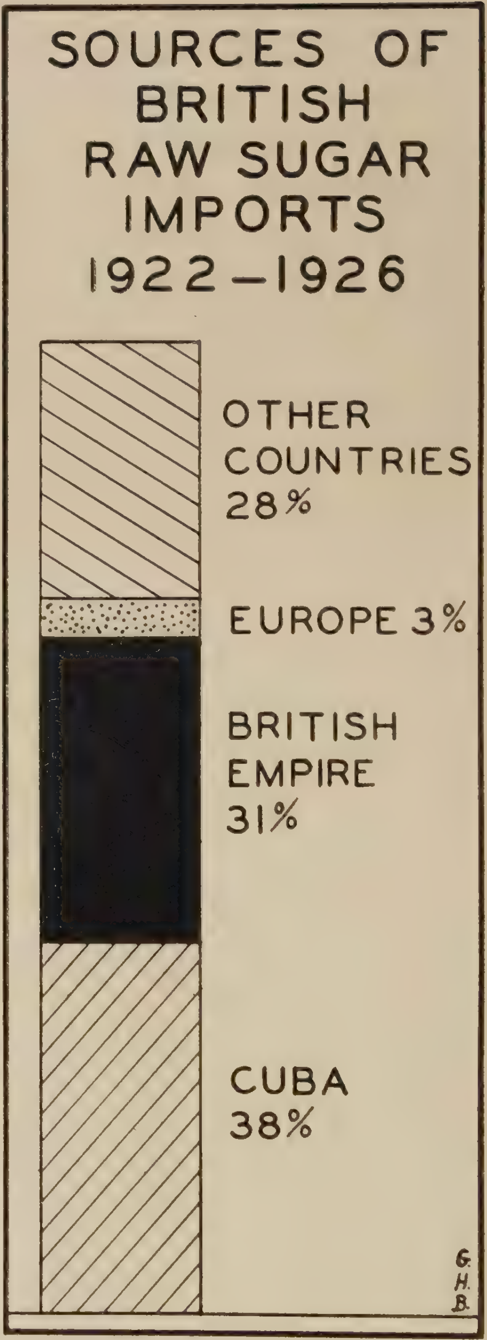

FIGURE 2.—The far-flung states of the British Commonwealth of Nations supply less than one-third of the imports of sugar into Britain.

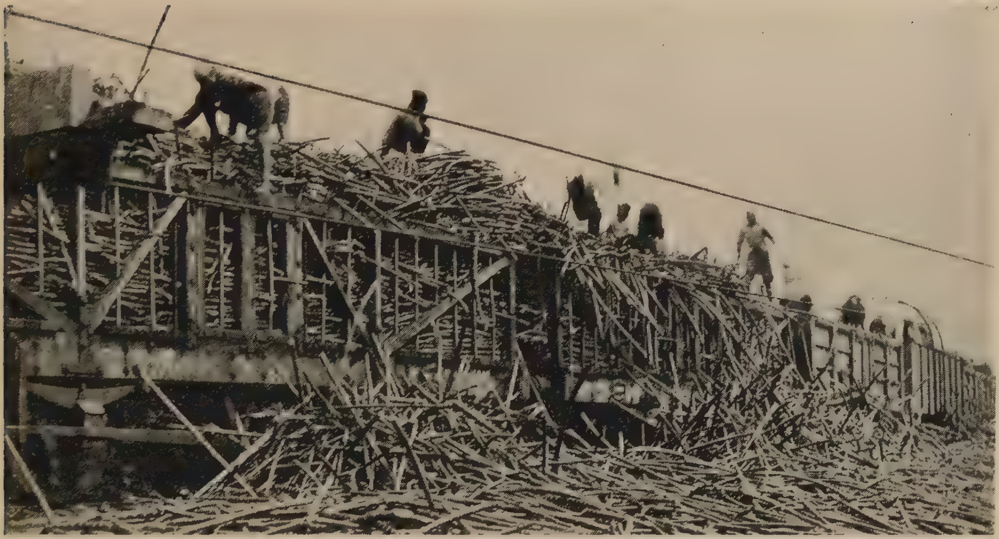

FIGURE 3.—Mauritius: Unloading the cane from railway trucks at the factory. The Government railways are largely used for cane transport. (Courtesy of Miss M. Freeland.)

their National and Colonial producers, and to arrange that wherever possible such terms shall take the form of money value preferences in import duties stabilised for a period of years." In furtherance of this policy its programme includes not only the organisation of propaganda but the encouragement of technical research. Funds are being provided by a voluntary levy of six pence per ton of sugar produced, already agreed on by Australia, Natal, and Mauritius.

From 1874 to 1901 Great Britain had a "free breakfast-table" as far as sugar was concerned, there being no duty of any sort in this period. In the latter year, however, a revenue duty was imposed, subsequently reduced, and then raised again during the War to an unprecedented level. In 1919 the preferential principle, too, was introduced for the first time, in favour of the colonial producers. This preference, for which a minimum at the rate of 4s. 3⅓d. per cwt. for sugar exceeding 98° polarisation was stabilised in 1925 for a period of ten years, was raised in 1928 to 6s. 10$^{8}/_{10}$d. on sugar exceeding 98° and not exceeding 99°, and 5s. 10d. on sugar exceeding 99°, on a gross duty of 11s. 8d. on all sugar exceeding 98°. Complete remission of duty on Empire sugars is now the avowed aim of the Sugar Federation.

IMPORTS OF RAW SUGAR TO GREAT BRITAIN FROM BRITISH EMPIRE *
(In thousands of long tons)

	1923	*1924*	*1925*	*1926*	*1927*	*Average*	*Per Cent of Total Import*
Mauritius	223	124	85	204	194	166	14
British West Indies	99	56	129	99	94	95	8
Australia	8	44	89	151	82	75	6
Natal	29	8	36	58	44	35	3
Total import	1,168	1,170	1,335	1,069	1,175	1,183	....
Per cent from Empire	33	25	25	48	35	....	....

* Annual statement of the trade of the United Kingdom, etc., and accounts relating to the trade and navigation of the United Kingdom.

CANE-GROWING REGIONS OF THE BRITISH EMPIRE
PRODUCTION OF RAW CANE-SUGAR IN THE BRITISH EMPIRE
(In thousands of long tons)

	1921–1922	1922–1923	1923–1924	1924–1925	1925–1926
British India *	2,614	3,045	3,317	2,546	2,977
Australia	300	306	286	436	522
British West Indies	274	273	256	285	295
Mauritius †	193	224	198	220	236
Natal ‡	132	142	181	144	214
Fiji	72	35	64	100	71
Total British Empire, excluding India	971	980	985	1,185	1,338
Total British Empire, including India	3,585	4,025	4,302	3,731	4,315
Total world	17,615	18,120	20,115	23,641	24,600
British Empire, Per cent	20	22	21	16	17

* Indian statistics are particularly unreliable, and in any case are not strictly comparable with others, as they refer only to a crude form of sugar.

† Mauritius statistics, usually given in metric tons, have been here converted to long tons.

‡ Natal statistics, usually given in short tons, have been here converted to long tons.

In 1913 the proportion of Empire sugar in the total British import of raw sugar was only 7 per cent, so the advance since the War has been considerable.

Roughly, one-fifth of the world's sugar is thus produced within the British Empire. The above statistics of production take no account of the beet-sugar production in British countries, but this is a comparatively insignificant figure, and would raise the British proportion only very slightly. The large production of India is entirely consumed within its own boundaries, India being an importer of sugar. Although before the War that country was the world's greatest producer, with 14 per cent of the total in the five pre-war years, its rate of increase was already lagging behind that of the world, while Cuba's was outrunning the latter.

Although the British cane-growing regions are widely scattered, there are sufficient points of resemblance in their conditions and problems to make possible a certain unity of treatment in discussing them, especially when India is excluded. That this is so, is, of course, not only partly dependent on the inevitable similarity in the demands of the cane plant wherever it is grown, but also on several features common to the economic development of these tropical or subtropical lands.

CONDITIONS OF PRODUCTION OF SUGAR CANE

The climate most suitable for sugar cane is hot and humid.

Climate

As for temperature, the absence of frost is particularly desirable, as frost lowers the sugar content and

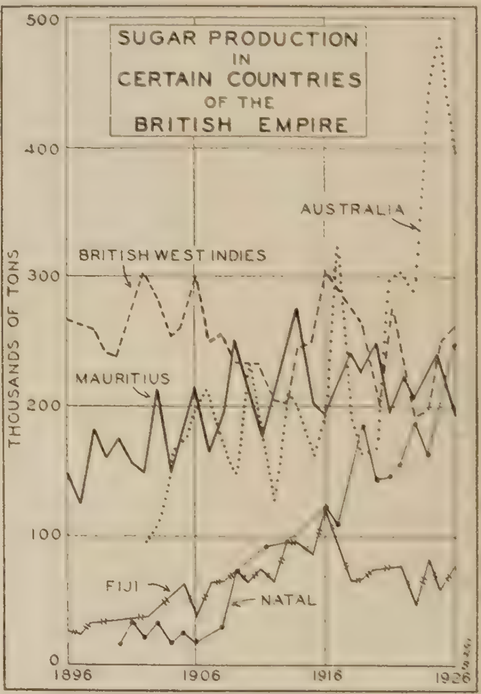

FIGURE 4.—Sugar production is declining in the British West Indies; holding steady in Mauritius and Fiji; responding rapidly to protection of domestic markets in Natal and Australia. For Mauritius the statistics are in metric tons; for the other countries, in long tons. (Source mainly *Statistical Abstract for British Empire.*)

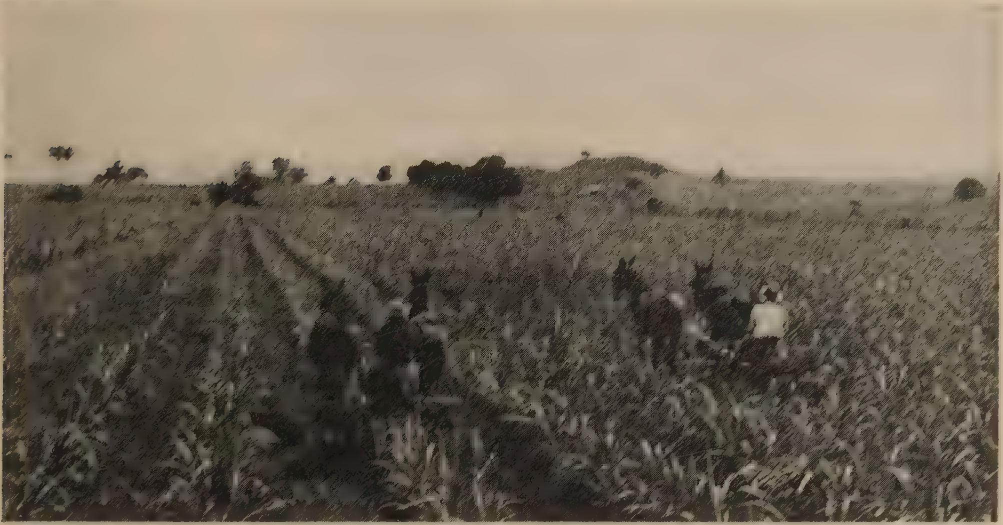

FIGURE 5.—A typical landscape in the sugar regions of Fiji. Mulching the soil between the rows and destroying weed growth by modern disk cultivators on the Navatu Estate, Rarawai, Fiji Islands. (Courtesy of Colonial Sugar Refining Co., Ltd., Sydney.)

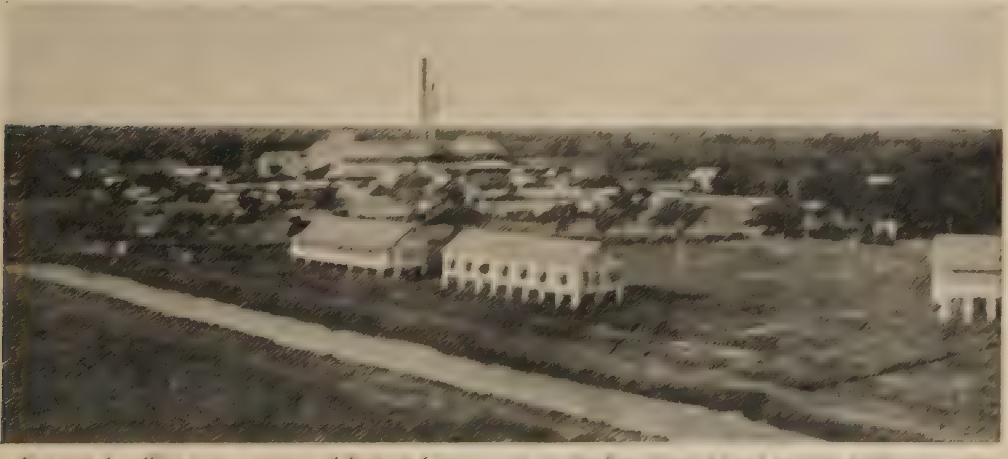

FIGURE 6.—The sugar estates of British Guiana are on the flat alluvial land mostly within six miles of the sea and to a large extent below the level of Ordinary Spring Tides. (Courtesy of "Empire Production" published by the British Empire Producers Organisation.)

decreases the purity of the juice. The rainfall régime allowing the best yields of sugar is one in which there is a well-marked alternation of wet and dry seasons, the wet summer allowing rapid growth and the drier and rather cooler season favouring increase of sugar content. So, the sugar-cane lands lie in the tropical or subtropical zones of summer rain. While total annual precipitation can only be a very general index, the minimum desirable is, as a rule, 40 inches; on the other hand, excessive moisture lowers sugar content and gives scope for fungoid diseases.

Soil

The cane generally thrives best on a loam or well-drained clay. The most popular cane soils in the British regions, as elsewhere, are the red

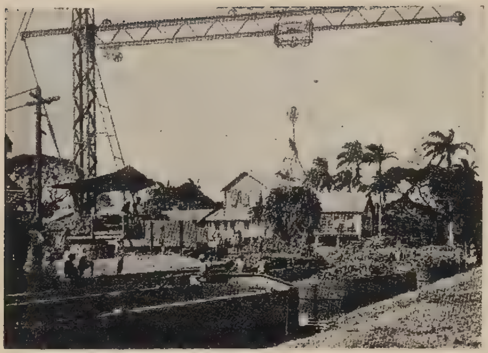

FIGURE 7.—In British Guiana, the drainage canals are used for transporting the cane to the factories, by iron "punts" hauled by mules. (Courtesy of "Empire Production," published by the British Empire Producers' Organisation.)

soils, fertile, and having great moisture-retaining capacity combined with easy drainage. Their comparative ease of cultivation is of the greatest economic importance. On the other hand, the rapidity with which leaching occurs leads to a growing demand for fertilizers in order to raise the level of yields. In practically all the regions deficiency in organic matter is one of the most serious problems.

Labour

Cane growing is voracious in its demand for labour, much of it exceedingly arduous. No matter how up-to-date mechanically an estate may be, much manual labour is still absolutely essential for cultivation and for harvesting. The cutting of the cane is an operation that still defies the machine-maker, and is not only extremely arduous but must also be performed rapidly in order to avoid deterioration in the cane juice and to keep the mill running at maximum capacity. Labour shortage, which is general in the Tropics, thus becomes particularly acute in the sugar industry. The immigration of labour into the sugar lands has, indeed, already a long history behind it. The sugar islands of the West Indies were, in fact, the first tropical lands to adopt this remedy on a large scale when they began to import slaves from West Africa in the fifteenth century. The abolition of slavery in British lands in 1834 cut away the labour basis of the sugar plantations both in the British West Indies and Mauritius and led to the widespread emigration of East Indians, mainly from the Upper Ganges Valley and Madras, as indentured labourers to the sugar colonies. The East Indian has been, and still is, the backbone of the British cane-sugar industry. Indentured immigration to Mauritius began in 1834 and lasted until 1910; in the British West Indies it continued from 1836 to 1917; in Natal from 1860 to 1911; in Fiji from 1879 to 1916. The indenture system came to an end because of the growth of opinion in India unfavourable towards it. Nevertheless, an East

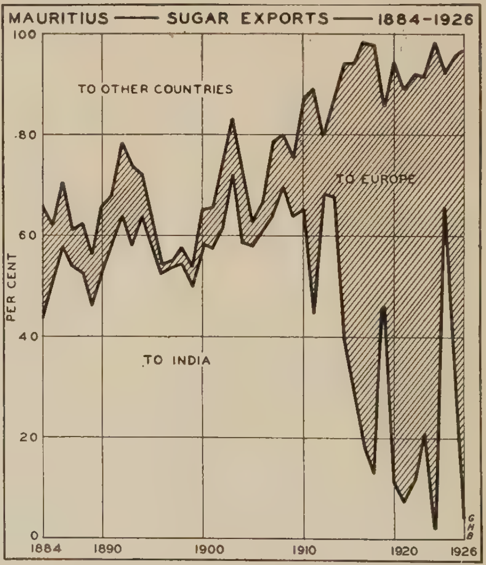

FIGURE 8.—The proportions of Mauritius sugar export shipped to India and to Europe indicate how proximity to a favourable market for long affected the shipments.

Figure 9.—Cutting sugar cane in Jamaica where negro labour plays a relatively greater part in the sugar industry than in other portions of the British West Indies. The machete or short cutlass is shown. (Courtesy of West India Committee, London.)

Indian population remains in these countries, forming in 1921 in Mauritius 71 per cent of the total population, in British Guiana 42 per cent, in Fiji 39 per cent, while in Natal it outnumbers the whites. The indenture system, while it lasted, had many weaknesses, such as the small proportion of women introduced, a mistake that, through the resulting slow natural growth of the immigrant population, has accentuated the labour shortage resulting from the abolition of the system. In Australia indentured labour consisted of Kanakas, natives of the Polynesian islands, introduced from 1864 to 1904; the problem there is peculiar, since the sugar industry now depends mainly on white labour.

In the countries of East Indian labour, given the very slow natural growth of the immigrant populations, labour shortage on the sugar estates has inevitably arisen with the increasing tendency of the East Indians either to take up small holdings or move to other industries. In Mauritius, in Fiji, and in some of the British West Indian islands, a class of peasant planters has arisen, which, however, owing to its lack of capital, the smallness of its holdings, its personal inefficiency, its slowness in adopting agricultural improvements, and, in some cases, its insecurity of tenure, has been unable to compensate by its efforts for the correspondingly smaller area of operation of the estates. In Mauritius about one-half of the cane land is now in the hands of the East Indians; in Fiji over half of the estates owned by the company controlling sugar production there have been parcelled out to East Indian tenants, and there are many independent small planters on the outskirts of the estates; and in Trinidad at least 60 per cent of the

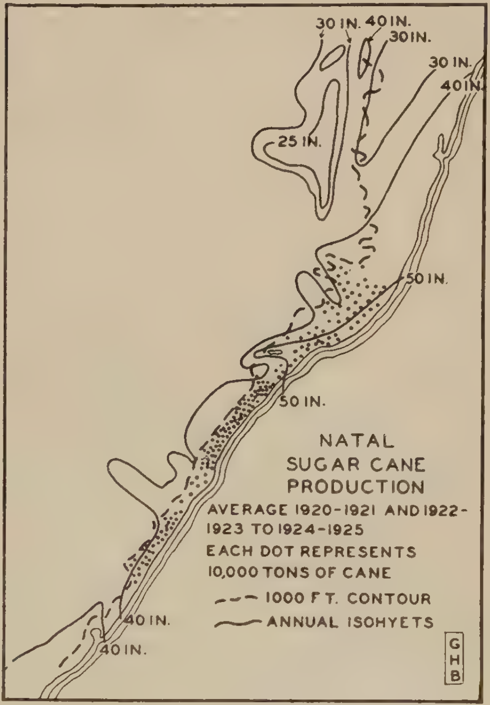
30 IN.
40 IN.
30 IN.
30 IN.
40 IN.
25 IN.
50 IN.
50 IN.
NATAL SUGAR CANE PRODUCTION
AVERAGE 1920-1921 AND 1922-1923 TO 1924-1925
EACH DOT REPRESENTS 10,000 TONS OF CANE
1000 FT. CONTOUR
ANNUAL ISOHYETS
40 IN.
40 IN.
G H B

Figure 10.—The production of sugar cane in Natal is confined almost entirely to the coastal belt. (Annual isohyets from Irrigation Department's Map by A. D. Lewis.)

"cane-farmers," mainly annual tenants, are East Indians. In Mauritius and Trinidad agricultural credit societies are assisting the movement.

The evolution of a community of small but efficient peasant planters must needs be slow. Meanwhile, the most generally adopted measure towards relieving the labour shortage is increased mechanization of the estates. The steam-plough and the motor-tractor are being gradually introduced throughout the British cane regions. A development of a quite different nature, that is of growing importance for the sugar industry as well as for other tropical industries, is the increasing attention given by the governments, as well as by many large estates, to measures of public health. The two greatest drags on the physical efficiency of tropical labour are malaria and hookworm, both especially prevalent in cane-growing districts by the very nature of these. The latter is prevalent in all the regions concerned, but the vigorous campaign against it, initiated throughout the Tropics by the Rockefeller Foundation, is already showing results. Many of the governments are also taking energetic measures against malaria, in Mauritius especially.

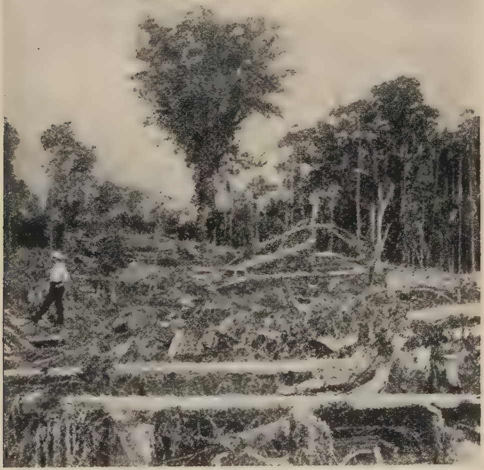

FIGURE 11.—Cleaning dense scrub in the tropical rain forest section of Queensland preparatory to clearing it by fire. The sugar fields of Australia are nearly all won from such lands as these. (Taken from "Queensland Sugar Industry," published by the Intelligence Bureau, Brisbane, Queensland, 1913.)

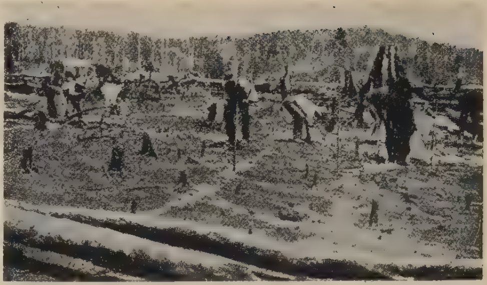

FIGURE 12.—Primitive sugar culture; planting with mattock on scrub land recently cleared. (Taken from "Queensland Sugar Industry.")

AGRICULTURAL RESEARCH

While labour shortage is still a great hindrance to improved methods of cultivation, the problem of increasing output per acre and per head is being approached from another direction in the breeding of improved varieties of cane. Higher-yielding canes, resistant to disease and adapted to local conditions of climate and soil, offer great possibilities. In the British West Indies, British Guiana and all the islands have their own agricultural departments, naturally devoting special attention to cane, while since 1922 the Imperial College of Tropical Agriculture in Trinidad, the first in the chain of research stations proposed to be established in the British Tropics,[1] has also devoted attention to sugar problems. In British Guiana, besides the sugar experiment station

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[1] See Report of Imperial Agricultural Research Conference, 1927.

FIGURE 13.—Planting by hand in open furrows in land only recently wrested from the forest. (Taken from "Queensland Sugar Industry.")

maintained by the local government, the planters run one with the assistance of a Government subsidy. The Imperial College is supported by voluntary contributions from the separate Colonies in the West Indies, in addition to having received financial aid from the Imperial Government. In Mauritius, where sugar has recently occupied up to 80 per cent of the cultivated area, the local Department of Agriculture inevitably devotes most of its energies to the crop. The industry in Natal has maintained a research station since 1926, while in Queensland the Bureau of Sugar Experiment Stations controls three stations, with two subsidiary entomological stations, all subsidised by the State Government. India has the famous sugar research station at Coimbatore. In Fiji the controlling company pursues an active research policy. In the British West Indies the seedling canes first produced in Barbados have now replaced the formerly predominant Bourbon. The movement towards coöperation in agricultural research generally has, in the last few years, received a great impulse, particularly by the meeting in London in 1927 of the first Imperial Agricultural Research Conference.

DEVELOPMENT OF THE RAW SUGAR FACTORY

On the manufacturing side the evolution in recent years has been towards the "central" raw sugar factory, drawing its cane from a very extensive area and having an annual output of up to 100,000 tons or more of sugar. Cuba, where this evolution has proceeded farthest, has peculiar advantages, natural and financial, in all forming a complex of favourable conditions that cannot be approached within the British Empire. Factory conditions in the British countries show great local variation, but in most cases there are great obstacles, physical as well as financial, to the evolution of the large-scale unit, with the economic advantages it possesses. The sugar industry in the British colonies has not attracted British capital as that of Cuba has attracted American. The history of the industry makes the reasons obvious.

FIGURE 14.—Machine planting supersedes hand planting on tracts which have been cleared for several years. Much of the labour on the sugar plantations is done by Italian immigrants. (Taken from "Queensland Sugar Industry.")

CLASSIFICATION OF CANE-SUGAR PRODUCING COUNTRIES OF THE BRITISH EMPIRE

The cane-sugar producing countries of the British Empire may be primarily grouped as "surplus" or "deficiency" countries, and, secondarily, according to the degree to which the complex of their present conditions of production makes them suitable for the industry. From these considerations there emerges the following economic classification:

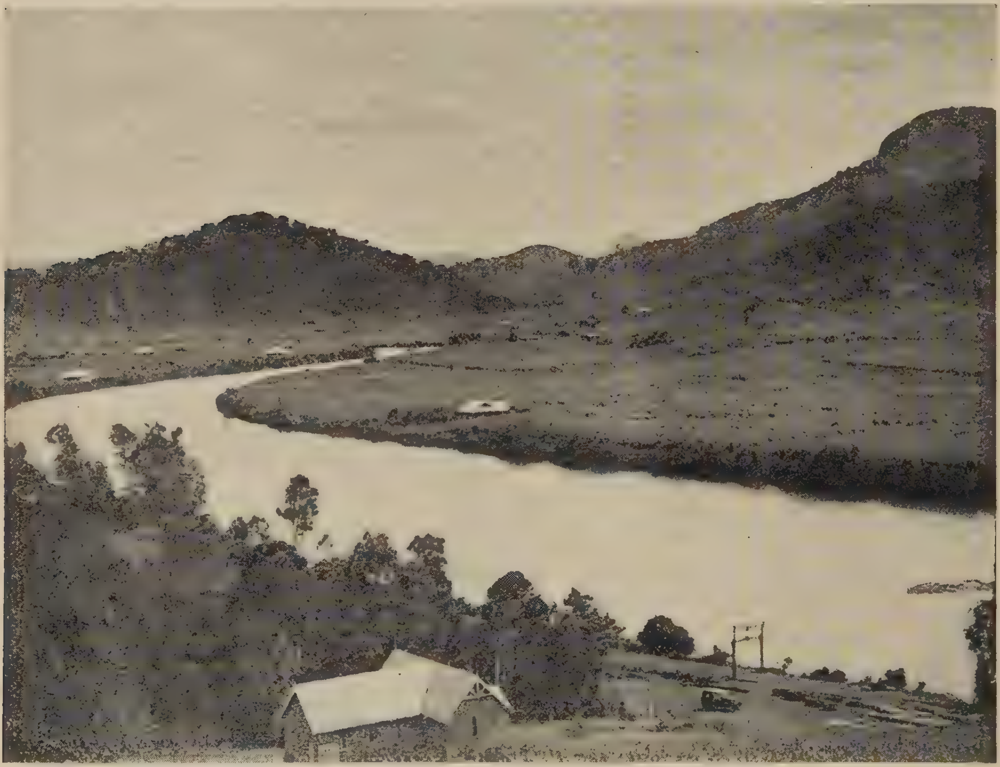

FIGURE 15.—Sugar farms on the Maroochy River, Queensland. The cane is grown mainly in the river valleys, the relief of the cane belt being very irregular. (Courtesy of Development and Migration Commission, Commonwealth of Australia.)

A. Surplus countries
  1. Conditions well-suited to sugar-production; normally able to compete in the free market.
    (a) Mauritius.
    (b) Fiji.
  2. Conditions unsatisfactory, but industry persisting, with tariff assistance.
    (a) British West Indies.
  3. Conditions definitely marginal, and industry being carried on only by means of a high degree of protection in the internal market and tariff assistance for exports.
    (a) Australia.
    (b) South Africa.

B. Deficiency country
  (a) India.

(A) MAURITIUS

(1a) Mauritius, Great Britain's island possession in the South Indian Ocean, was the first to rival the West Indies as a source of sugar for the mother country, having sent sugar regularly for more than a century. It is now, after a long interval of supplying the Indian market, the leading source of Great Britain's imports from within the Empire, practically the entire output being so absorbed. A large part of the island is covered by the fertile red soils, particularly in the southeast, where the chief producing districts are, and where too the climate is particularly suitable. Only occasionally do hurricanes pass near enough to cause serious damage; serious droughts are, however, still rarer. Mauritius has become a one-crop country, the best lands being already occupied by cane, much further extension being impossible. The island enjoys freedom from serious cane disease, the chief need on the agricultural side being measures to counteract the labour shortage, while on the manufacturing side further concentration of production is desirable, the relatively large number of small-scale factories making further improvement in efficiency difficult.

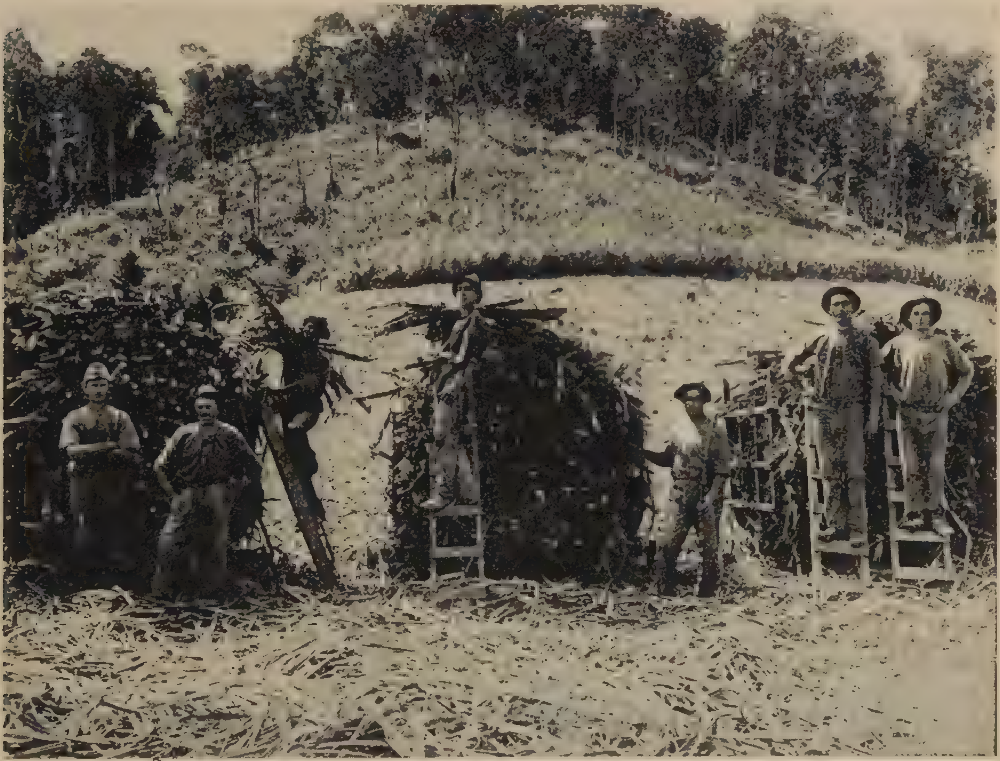

Figure 16.—Sugar cane cutting, Queensland. Cane cutting in Queensland is performed by white labour organized in gangs. (Courtesy of Commonwealth of Australia, Development and Migration Commission.)

(A) FIJI

(1b) In the Fiji Islands, the chief group in the South Pacific, cane is grown on the alluvial coastal flats and in the lower parts of the valleys, chiefly on the leeward side, on the two main islands—Viti Levu and Vanua Levu. While production is only about one-third that of Mauritius, it is exceptionally well organized, being controlled by a single company, owning five mills and the transport system of the colony. The company relies for its profits chiefly on its large refining business in Australia and New Zealand, Fiji having the advantage, unusual among British sugar colonies, of considerable financial resources behind the industry. The rapid introduction of machinery and the encouragement of coöperative cane farming are going far to solve the labour problem. The sugar is exported mainly to New Zealand, the Australian market being closed by an embargo on sugar produced by coloured labour. New Zealand, however, though it has a very high per capita consumption, has a small population and so offers only a limited market, but in recent years the British preference has enabled part of the surplus to be exported to Great Britain.

(A) BRITISH WEST INDIES

(2a) The British West Indies, Great Britain's "classical" sugar colonies, are on the whole climatically suited to sugar cane, though Barbados and the Leewards, for instance, approach marginal rainfall conditions. Their soils vary from the light, easily-worked red soils of Barbados to the heavy alluvial clays of British Guiana. The "sugar islands" occupied a key position in the economic organization of the Old Colonial Empire. With the nineteenth century came disaster to the planters. First, the competition of slave-grown sugar cane when the system of slavery had been abolished in the British colonies, but this competition was surpassed in the latter half of the century by that of European beet sugar. By 1897, when the intervention of the Imperial Government brought a turning-point in British West Indian history, the area under sugar cane had shrunk to its smallest dimensions. Since then, however, a number of expedients have enabled the industry to survive, and, while in some areas the decline has continued, in others there has been a slight expansion on the low level with which the century ended. They are as follows:

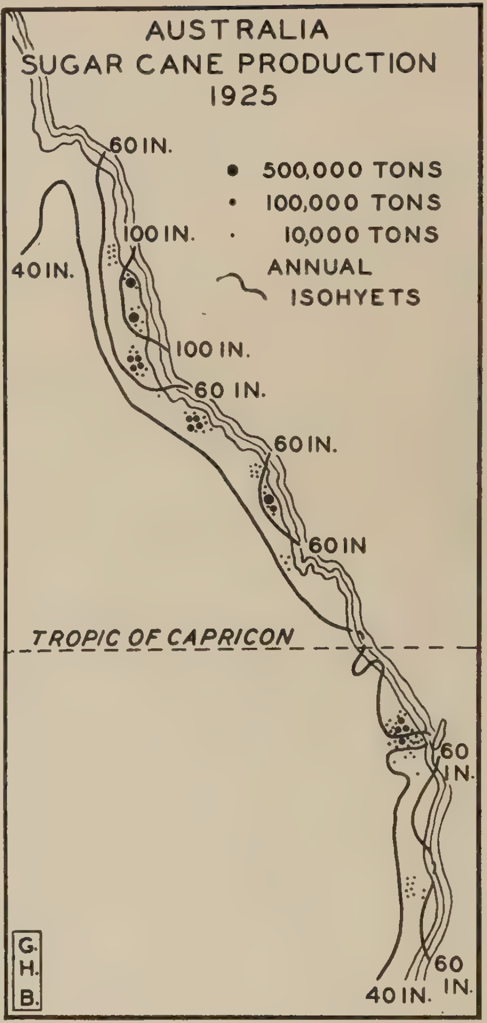

FIGURE 17.—It is on the warm, damp, coastal border of Queensland that most of the Australian sugar is produced.

(1) Sugar cane has been, to an extent varying in different colonies, confined to the areas where climate and soil are best suited to it. This process, which has gone farthest in Trinidad,[2] has helped to improve the economic position.

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[2] See James, P. E., ECONOMIC GEOGRAPHY, January, 1927, "A Geographic Reconnaissance of Trinidad."

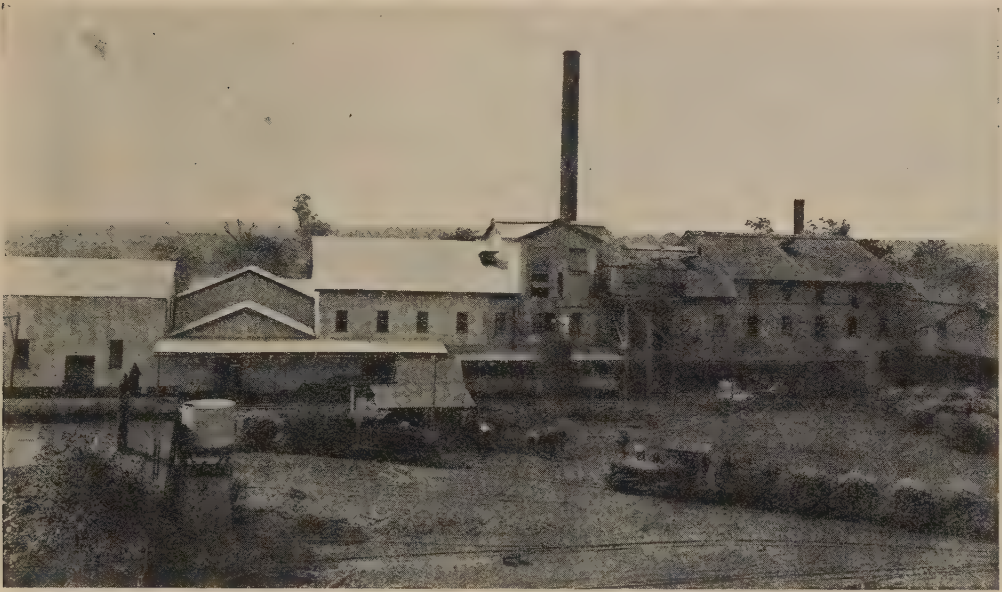

Figure 18.—A Queensland sugar mill. The cane is transported to the mill on narrow gauge railways. In this type of factory with several floors, advantage is taken of gravity in passing the material from one stage of manufacture to another. (Courtesy of Commonwealth Immigration Office.)

(2) Closely connected with the above has been the adoption or extension of other crops better adapted to local conditions and to the needs of the world market. Instances are the banana in Jamaica, cacao in Trinidad, and coconuts, cotton, and limes in Antigua and St. Lucia. In some smaller islands there has also been increased cultivation of "ground provisions." This process of diversification has brought satisfactory results, both agriculturally and financially.

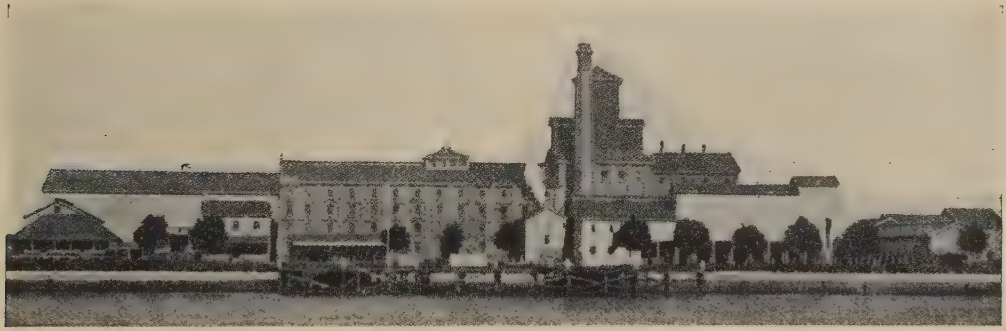

Figure 19.—Colonial Sugar Refining Company's refinery, New Farm, Brisbane. (Courtesy of "Queensland Sugar Industry," published by the Intelligence Bureau, Brisbane, Queensland, 1913.)

(3) In Jamaica, specialisation on a by-product, rum, has done much to keep land under cane, though it has led to the neglect of efficiency in sugar production in the factory. Elsewhere, by-products are of secondary importance, though British Guiana still has a large rum export and Barbados now commands the market for fancy molasses.

(4) Until the Cuban Reciprocity Treaty of 1903 the American market was the chief outlet for British West

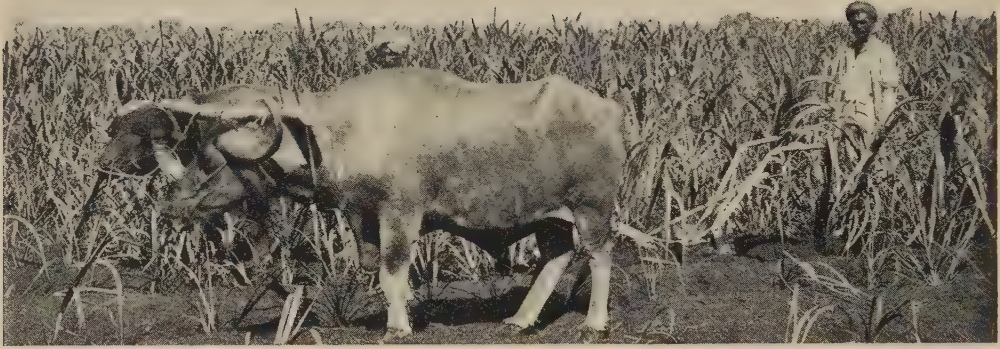

Figure 20.—Earthing up cane with the Sabul plough in India. (Courtesy of Trade Commissioner for India, London.)

Indian sugars, their position being strengthened by the American countervailing duties on bounty-fed sugar. In 1903 the Brussels Convention brought some relief in the British market, and meanwhile, since 1898, Canada had begun to give a preference, since then increased and embodied in a series of trade agreements, the latest of which, in 1925, gives a preference at the rate of $1.00 per 100 pounds for sugar over 95° and not over 96° polarisation. The British preference since 1919 has, of course, greatly strengthened such assistance.

(5) The high prices of the years immediately following the War helped the industry.

(6) Added to these influences has been a sort of inertia that has helped many old and sometimes unprogressive estates with family traditions to keep going through a prolonged period of depression, whereas greater enterprise would have caused the abandonment of the sugar industry for some more profitable activity.

These various influences together have just enabled the industry to survive. It is still faced with great difficulties, encountered here in an accentuated form. On the agricultural side, the shortage of labour is particularly acutely felt in British Guiana and Trinidad, their heavy soils requiring much cultivation. On the manufacturing side, not only financial difficulty but physical conditions, such as the small size of some islands or, as in Jamaica, the scattered distribution of the cane lands and difficulties of transport, are great obstacles to "centralization." At the same time, while the British areas can never hope to have "centrals" on the Cuban scale, considerable advantage has been derived from efficient factories of a more modest size, examples of which are in Trinidad, Antigua, St. Kitts, and Jamaica.

(A) NATAL AND QUEENSLAND

(3a and 3b) In Natal the sugar belt stretches along the coast as far south as 31°, while in Australia the long-drawn chain of cane districts

Average Export from British West Indies, 1922–1926 *

	Sugar (1,000 tons)	*Rum* (1,000 gals.)	*Molasses* (1,000 gals.)
British Guiana	89	710	4,667
Trinidad	51	46	877
Barbados	44	14	6,655
Jamaica	37	778	...
St. Kitts-Nevis	12	...	329
Antigua	11	...	257
St. Lucia	4	...	147
St. Vincent	..	...	257
British West Indies, total	248	1,548	10,028

* Statistics from the annual reports of the colonies concerned.

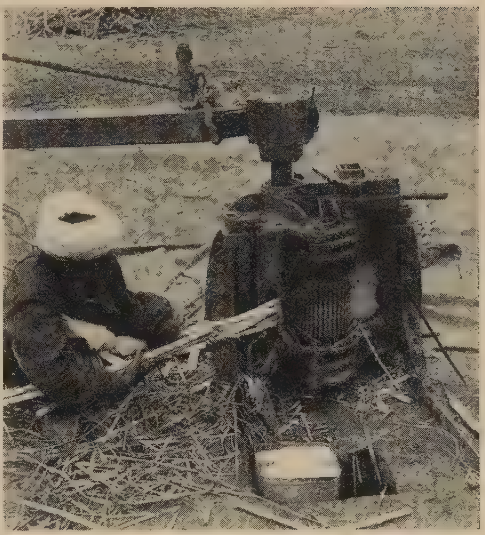

Figure 21.—Small iron cane crusher now largely used in India. Driven by bullocks. (Courtesy of Trade Commissioner for India, London.)

stretches along the Queensland coast to 30° S. In the southern parts of both regions temperature is distinctly marginal, frosts causing considerable damage, particularly in Australia. In both the 40-inch isohyet marks the lower rainful limit of most of the cane land, but in Australia there is sufficient cane grown beyond this limit in the south to make losses severe in a dry year. In both regions the centre of production is, in fact, tending northwards. Not only are considerable parts of these regions marginal climatically, but also are they, as a whole, severely handicapped in their labour conditions, Australia peculiarly so. In Natal, since the breakdown of the East Indian indenture system, the industry has depended mainly on Bantu Negroes, 75 per cent of whom now have to be drawn from other parts of the South African Union. Not only is this labour insufficient in quantity, but also is it unsatisfactory in quality. Australia, since it expelled most of the Kanakas in 1906, has, in order to carry out its policy of a "White Australia" by settling a white population along the hot and humid Queensland coast, placed very severe restrictions on the employment of coloured labour. No white man may employ coloured labour in cane-cutting, nor may it be employed in cultivation on ploughed land on any farm with over 75 acres under cane. As the white cane-cutters receive relatively high wages compared with those paid in other sugar-producing regions, the costs of production are very high. At first the industry was assisted by a bounty; later it was protected by a high tariff. This was not satisfactory, so ultimately the entire prohibition of import was found necessary. Natal sugar has protection in the South African market of £7 a ton. But, in both cases, these highly-protected internal markets are limited in extent, and both industries are faced with the problem of disposing of an export surplus. Only by means of a British preference maintained at a high level can they do so without serious loss, especially on Australia's part.

(B) INDIA

(a) In India 90 per cent of the cane is grown in the Indo-Gangetic Plain, that is, mainly outside the Tropics. Over half the area is in the United Provinces. There is a smaller pro-

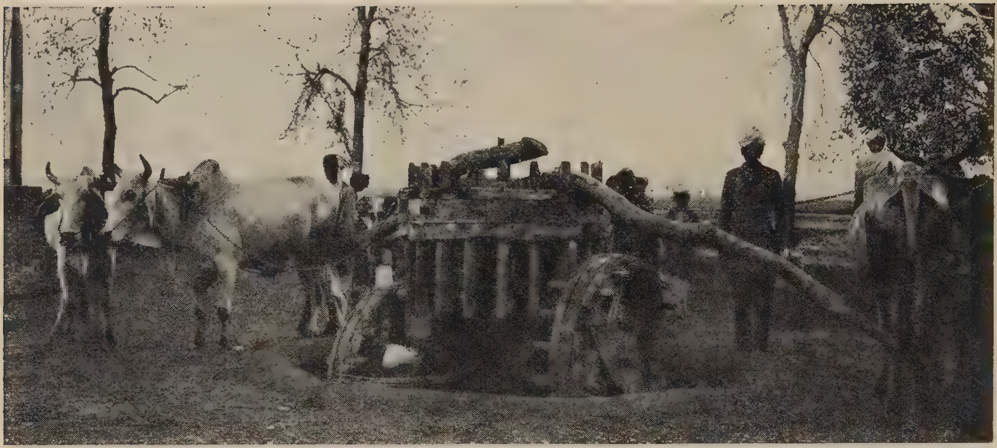

Figure 22.—Old style of very inefficient wooden bullock mill in India. Wooden bullock mills were used for extracting the juice from the cane. Such mills lost in the Megass over 30 per cent of available juice in the cane. (Courtesy of Trade Commissioner for India, London.)

duction in the Peninsula. Despite India's great output, second only to Cuba's, the crop in no part attains great relative importance, even in the United Provinces occupying less than 4 per cent of the total cultivated area. The climate in general is not favourable, the growing period being short, though hot and, in some provinces, humid. To enable cane to establish itself in the preceding hot, dry season, irrigation is necessary. In the extra-tropical area only the hard, thin North Indian canes mature, but there irrigation is cheaper and the light alluvial loams are relatively easily worked, though the red and black soils of the Dekkan give higher yields per acre. Not labour shortage but labour inefficiency is the chief hindrance to progress, which is, generally, however, bound up with the whole extremely complicated problem of improvement in Indian agriculture. Of the sugar produced, 99 per cent is in the form of "gur," which is simply cane juice concentrated until it is solid, practically without purification. The very low productivity per head ot population makes a large import necessary, and the value of the sugar import, which is mainly from Java, is surpassed only by that of the cotton piece-goods imported.

Largely as a result of the encouragement given by the Imperial Government to British producers, the proportion of British raw sugar imports from within the Empire, which had been 11 per cent in 1909–1913, had reached 49 per cent in 1926. What are the permanent prospects of such supplies? Does the geographical background exist in the British sugar-producing regions for the economic progress of the industry? As for the first question, the surplus countries with the most favourable conditions of production—Mauritius and Fiji—are those which are nearest the limits of their potential cane land. The British West Indies are unlikely to sacrifice the advantages of such diversification as has already been carried out, even if further help from the Imperial Government were to alleviate their difficulties in sugar production. Natal and Australia, which have considerable areas of potential cane land at their disposal, can utilise it only at the cost of

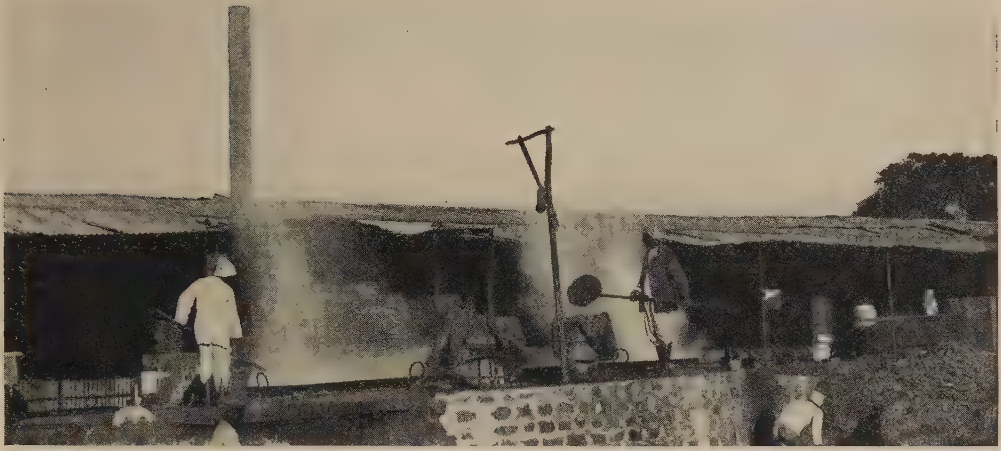

FIGURE 23.—India: Making gur, unpurified cane-juice, concentrated to solidity. Ninety-nine per cent of the sugar made in India is in this form. (Courtesy of Trade Commissioner for India, London.)

further lowering their average returns and at the risk of further loss in disposing of the export surplus. In every instance the future of economic production rests with the raising of average yields in field and factory, that is, in intensifying production rather than in extending the area under cane and, given the geographical conditions of the British sugar-producing regions, the proportion of British sugar in the imports of Great Britain may in this way be increased, at least cost to the consumer and taxpayer, and with the minimum of opposition.

RAINFALL AND WIND CONDITIONS RETARDING TROPICAL DEVELOPMENT

Stephen S. Visher
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DURING the last two centuries white man has occupied nearly all middle latitudes. The chief exceptions are the parts occupied by the Japanese and Chinese, where, nevertheless, Western civilization has penetrated notably. In contrast to this conspicuous success in middle latitudes is comparative failure in the tropics, where there are very few white families and where white man's civilization has made relatively little impression.

Introduction

Can white man and his civilization spread into the tropics and occupy it successfully? White man is said to be at the crossroads; his progress during recent centuries has been very rapid, but now the future seems dark to many observers. Yet, nearly a quarter of the land of the world is almost unused, and that quarter receives the most energy from the sun, and much of it receives considerable rainfall, or has other valuable assets.

The failure of white man to occupy any considerable share of the tropical half of the world is not due to any single factor, but to a combination of unfavorable conditions. Some of these unfavorable conditions have long been recognized; others have only recently been appreciated; perhaps some are still unsuspected. If white man is to succeed in his efforts to effectively use the resources of the tropics, careful study must be made of all the factors operating. This calls for specialization and cooperation.

The purpose of this article is to call further attention to and discuss the baneful influences of certain aspects of the rainfall and winds which have retarded tropical development. However, in order to give proper prospective, it seems desirable to briefly consider other conditions which have interfered with white man's occupation.

OTHER DETERRENTS TO CIVILIZATION IN THE TROPICS

The high death rate prevalent in the tropics has been a powerful factor, by destroying many of those who have gone, and by discouraging others from going. Although yellow fever and malaria have been largely conquered, and other diseases reduced, the death rate as of a normal (unselected) population still remains high. This casts doubt upon the optimism of those who have assumed that the conquest of the tropics can proceed rapidly as soon as methods of successfully combating important tropical diseases have been discovered and applied.

Ellsworth Huntington has discovered that the optimum temperature for man's physical activity and especially for his mental activity is considerably below that characteristic of tropical lowlands. How detrimental this is cannot now be determined. Neither can one now discover how much of a handicap are the relatively small ranges of temperature from day to day and from season to season, also suspected by Huntington of being significant.

Several other conditions have been recognized as having contributed to white man's failure in the tropics. One of these is the presence in humid regions of a superabundance of wild animal and plant life. Animals of all sizes attack man and his domesticated plants and animals. Some of the larger wild plants serve as weeds, crowding cultivated plants, or soon blocking trails and roads. Some of the smaller plants (bacteria, moulds, fungi) induce disease and decay. Another unfavorable condition is the relative infertility of the soil in the rainier regions, except on areas often flooded by streams or slope wash. Other exceptions are scattered areas where removal is rapid enough to expose unleached, fertile materials, but slow enough to permit a considerable depth of soil to persist.

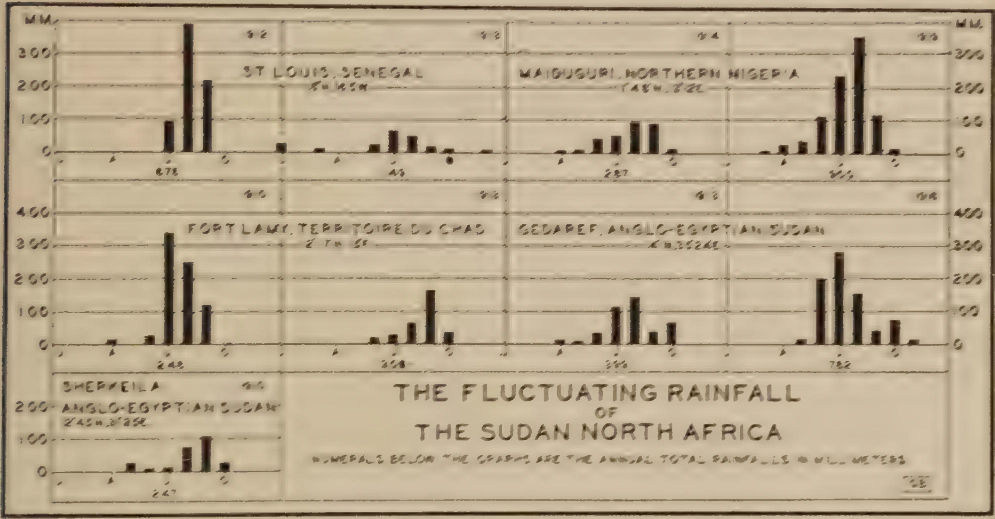

Figure 1.—Some variations in the annual rainfall of the North African Sudan. (Data from G. T. Renner, *Geographical Review*, October, 1926.)

The presence of a native population which lives on a low social plane has also been unfavorable to white man's civilization, for such a population furnishes cheap servants, but leads to physical labor being despised, and to other unfortunate conditions. It powerfully retards or prevents the development of a large, thoroughly substantial, middle-class white population.

The ideals of the people who have gone to the tropics have also been blamed for white man's failure there; for most men have gone to the tropics to exploit the resources and natives, having no intention of making a real home. Few women have gone, and most of those have led a highly artificial life, because of their attitude toward life in the tropics, and their numerous servants. In brief, home life comparable to that prevalent in mid-latitudes has seldom been attempted in the tropics; admittedly, without real home life, occupation cannot be successful.

Importance of a Fuller Knowledge of Climatic Conditions

The foregoing conditions unquestionably have retarded the spread of white man's civilization into the tropics. They may even prevent the development of an indigenous, permanent civilization of high order. But, sufficient knowledge and capital, and their adequate use, may overcome these handicaps sufficiently to enable white man to develop the resources of the tropics even if he can not build up a civilization comparable to that of mid-latitudes. In order, however, to develop tropical resources without enormous waste of effort, capital, and life, climatic conditions must be well understood. Most of the published data deal with averages, but averages have little significance; life is affected by actual conditions, not by averages. Two climatic conditions of great significance are rainfall dependability and wind storms. These conditions have been studied in widely separated sections of the tropics by the present writer who is convinced that they are important deterrents to tropical development. Strange to say, both have been largely ignored in spite of their importance and the fact that data for their evaluation is available, or may be readily gathered.

RAINFALL DEPENDABILITY: ITS IMPORTANCE

As precipitation is essential to farming, stock raising, and many other human activities, its dependability is of vital importance. Nowhere is a uniform amount received in corresponding seasons year after year, but in some regions the supply is much more dependable than in others. The regions of greatest dependability are the humid sections of mid-latitudes, especially those characterized by frequent changes of weather, caused by the passage of numerous cyclonic disturbances, the lows of which induce rainfall. Furthermore, in mid-latitudes during the colder season, considerable periods with slight precipitation cause little damage. In contrast, in the tropics it is warm throughout the year, and evaporation is rapid, partly because on the average, the warm air there can hold three times as much moisture as can the cooler air of mid-latitudes.

ERRATIC RAINFALL OF ARID REGIONS

All arid regions are characterized quite as truly by highly erratic as by scanty average rainfall. From time to time rainy spells, usually "cloudbursts," produce striking effects. Train service is most frequently interrupted by floods in arid regions, partly because proper provision against flood waters has been hard to make. Many a shallow valley which today seems entirely innocent, or to require merely a culvert, tomorrow may be filled with a raging torrent requiring a wide bridge.

Warm deserts are especially subject to wide fluctuations in rainfall. For example, Helwan, Egypt, has received eighteen times as much rainfall in one year as another, and Onslow, a small port of tropical Western Australia, forty-seven times as much. Even greater extremes are recorded in regions where occasionally a year passes with no rainfall at all, as in Sonora, northwestern Mexico, and in tropical Chile. In northern Chile and southwestern Peru, although several years without rain sometimes occur, nevertheless continued and heavy rainfall is also known occasionally. This was true in 1925, 1918, 1891, and from time to time as far back as written records or legends go. The character of the older sedimentary deposits show that such alternations of extreme drought and con-

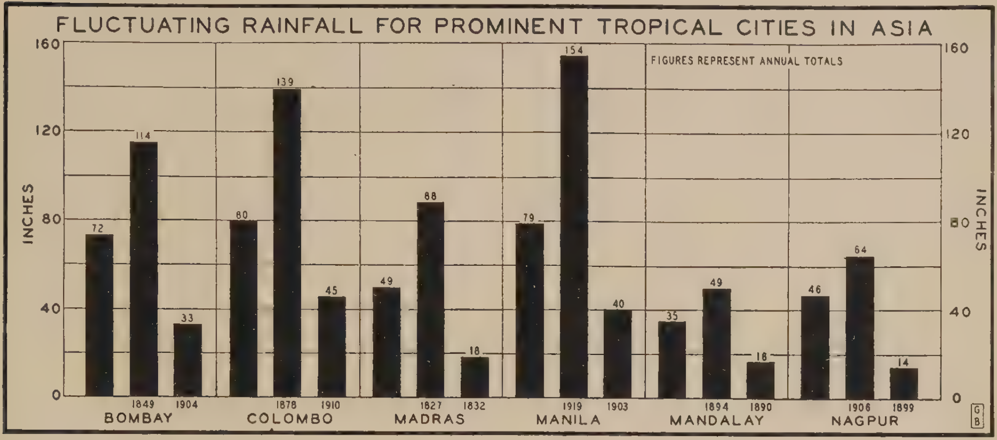

FIGURE 2.—The distinctive wide fluctuation in tropical rainfall is clearly revealed by this chart of several representative cities of Asia. (Data mostly from World Weather Records, Smithsonian Institution, 1927.)

siderable rainfall have persisted for geologic ages. The floods of 1925 caused great damage to towns, crops, native birds, and other life not adjusted to rainy conditions. Much valuable nitrate and guano fertilizer which had accumulated during the preceding rainless period was washed into the sea by the floods. Furthermore, the guano-yielding sea birds were greatly reduced in numbers by the destruction of eggs by the rain and by the death of adults by disease. Diseases spread because the changed temperature conditions in the Humboldt Current, which induced the abnormal rainfall, were fatal to many of the fish which form the chief food supply of the birds.

FLUCTUATING RAINFALL OF SEMI-ARID REGIONS

In semi-arid regions, fluctuation of rainfall has greater economic consequences than in arid, because in semi-arid regions in an average year, numerous livestock can be grazed, and in good years the yield of crops may be excellent. Hence, human occupation is invited, and the losses during dry years are much greater than in arid regions, which, except where irrigated or mineralized, never support many people or stock. For these reasons, drought causes much greater loss in eastern Australia, where the rainfall averages over fifteen inches, than in the drier section. The losses would be even greater if the Australians did not have the ability, knowledge, and capital to adjust their activities rather well to the fluctuating rainfall. In the Sudan of North Africa and in much of South Africa, the erratic rainfall frequently causes much loss of life and property. Another tropical semi-arid area which suffers frequently and severely from drought is northeastern Brazil.

UNDEPENDABLE RAINFALL IN THE WET TROPICS

The indications are clear, moreover, that in even the rainier tropical regions the rainfall is decidedly undependable. Illustrations of the fluctuations at certain tropical cities and areas are given elsewhere, but may be summarized here. Among scattered low latitude cities having thirty inches or more a year, on the average, in no case was the officially recorded rainfall of the wettest year less than twice that of the driest. Only in Calcutta, India, and in Caracas, Venezuela, did the ratio fall as low as 2¼. In Johannesburg, South Africa, it was 2½ times as great; in Durban, South Africa; Hongkong, British China; and New Orleans, Louisiana, it was about 2¾ times as great. In Colombo, Ceylon, and Honolulu, Hawaii, it was about three times; in Bombay, India, and Manila, Philippine Islands, each about 3½ times; in Madras, India, 4½ times; in Brisbane, Queensland, and Singapore, Straits Settlements, five times; and Forteleza, Brazil, six times. Equatorial Ocean Island (longitude 169° E.) received eight times as much rain in 1905 as in 1909 (19.6 inches vs. 158.9 inches); Malden Island (latitude 4° S., longitude 155° W.) 2,000 miles east of Ocean Island, received sixteen times as much rain in 1905 as in 1908 (3.9 inches vs. 69.4 inches). The average rainfall for each of these places is over thirty inches and the mean for the group is 58 inches. The records are of varying length, but in most cases not long. Indeed a five- or ten-year record for a tropical station generally includes a year having more than twice as much rainfall as the driest year.

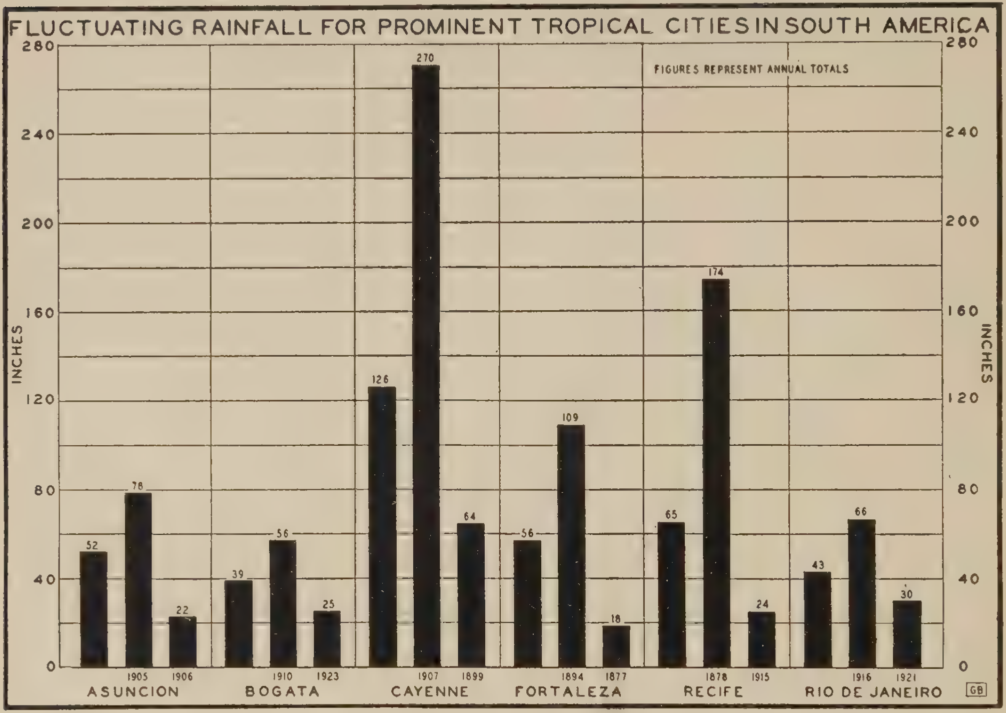

FIGURE 3.—South American cities reveal the same fluctuation in rainfall as do the tropical cities of other lands. (Data mostly from World Weather Records, Smithsonian Institution, 1927.)

In contrast, the much longer records of many mid-latitude cities fail to reveal any such extremes in rainfall. For example, the maximum rainfall received in any year since the records commenced, many decades ago, at Chicago, Edinburgh, Oslo, Ottawa, Paris, Peking, and Tokyo was less than twice the minimum rainfall. It was only a trifle more than twice the minimum in the case of Amsterdam, Berlin, Berne, London, New York, Leningrad, St. Louis, and Wellington, New Zealand. The records of some of these cities extend over two centuries.

That the contrast in rainfall dependability illustrated by these cities, selected solely because data for them were available, is not local is suggested by various data. For example, the average rainfall of the entire Hawaiian group (150 stations) was more than twice as great in 1919 as in 1918 (112.9 inches compared with 54.5 inches). In the Philippines also, according to Coronas, droughts generally affect the whole archipelago. Likewise in Cuba, 19 scattered stations had an average rainfall of twice as much one year as the next (75.3 vs. 36.6 inches). Yet, the rainfall of Cuba is characterized by Dr. Fassig, U. S. Meteorologist for the West Indies, as notably dependable, especially in the warmer months, as compared with other West Indian Islands. In 28 years (1899 to 1924) the average summer rainfall of Cuba ranged 16.3 inches (from 11.6 to 27.9 inches), and for the six warmer months (April to September) it ranged 19.7 inches (from 27.9 to 47.6 inches).

In contrast to these Hawaiian, Philippine, and Cuban conditions, comparison may be made with the rainfall dependability of Indiana, a state comparable with Cuba in area and average rainfall. The same 28-year period includes no year when the average rainfall for Indiana departed as much as nine inches from the normal amount (39.2 inches). During the three summer months the extreme range at Indianapolis was seven inches, in contrast with 16.3 inches for Cuba. During the warmest six months it was 10.9 inches, or only slightly over half Cuba's range.

Many of the detrimental effects of wide, erratic fluctuations in the rainfall are obvious. The dry spells commonly result in reduced yields of crops, of grass for grazing animals, and of water supply for man and beast. Often the spread of disease is facilitated by the weakened conditions, due to partial starvation. Sometimes the abundance of mosquitoes is increased by the converting of former streams into series of stagnant pools. The periods of excessive rainfall are less obviously detrimental, but nevertheless cause much harm by interfering with commerce, farming, and other outdoor work, by causing floods which injure roads and bridges and by stimulating the growth of weeds and other rank vegetation. That acceleration of vegetative growth of cultivated crops is by no means uniformly desirable is proved by the reduced sugar content per acre of cane in wet years, and the spread of wilt in the tobacco, and the deterioration of bananas.

The uncertainty of financial returns which results from the relatively erratic rainfall of the tropics has deterred numerous capable northerners from exploiting the tropics; for capable people wish to be reasonably sure of at least a fair return for their efforts.

UNFAVORABLE SEASONAL CONCENTRATION OF RAINFALL

Another great aspect of tropical rainfall which is detrimental to tropical development is the large extent to which it is concentrated in certain seasons. This concentration is well known, as even in the elementary schools children are taught that the seasons of the tropics are "wet" and "dry" rather than "summer" and "winter." The detrimental effects of such a rainfall distribution are not, however, adequately realized. The high tropical temperatures induce such rapid evaporation that soon the soil is parched, roads and fields become very dusty, vegetation withers. Indeed in a large share of the tropics, the vegetation, except where irrigated, is largely dormant during much of the dry seasons. Streams cease to flow, the water-table falls; water supplies for man and beast become limited and contaminated, and death rates rise. During the wet season, however, the rain often is so abundant as to produce a "sea of mud," swollen streams, excessive atmospheric humidity, and other unfavorable conditions.

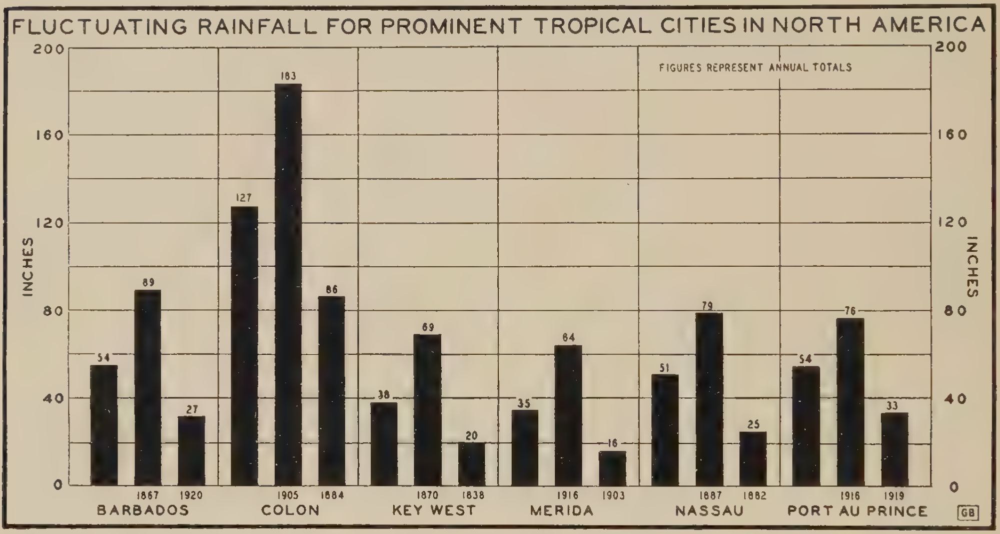

FIGURE 4.—The typical fluctuation of the rainfall of tropical cities in North America is illustrated by this chart of data from six representative cities. (Data mostly from World Weather Records, Smithsonian Institution, 1927.)

TORRENTIAL CHARACTER OF TROPICAL RAINFALL

Tropical rainfall is not only erratic and largely seasonal, but is characteristically torrential. Instead of falling gently as is usual in middle latitudes, most tropical rains are of the thunderstorm type, with large drops and a copiousness unknown in cooler regions. There are innumerable tropical stations with records of a fall of more than ten inches of rain in twenty-four hours, many with over twenty inches, dozens with over thirty inches, six of over thirty-five, and three of over forty inches in twenty-four hours. The world record for twenty-four consecutive hours is forty-six inches, near Manila; but several widely separated tropical rainfall stations have received more than forty inches within forty-eight hours. In other words, excessive falls within short periods are of greater magnitude and are more frequent in the tropics than in middle latitudes. All of the records of thirty inches or more of rainfall within twenty-four hours are from tropical latitudes, as are nearly all records in excess of ten inches. In the

United States, in contrast, in twenty years the only areas receiving over ten inches in twenty-four consecutive hours were along the Gulf Coast. No area in the northern third of the country received over six inches, while nearly five-sixths of the northern border had an extreme maximum of less than four inches.

The detrimental effects of such "cloudbursts" as are frequent in the tropics are largely obvious. When as much rain falls in a day as most of the middle latitudes receive in a month or even in a year, much soil washes away, many roads and trails are damaged, and a severe strain is imposed on all structural evidences of civilization, such as buildings and sewers.

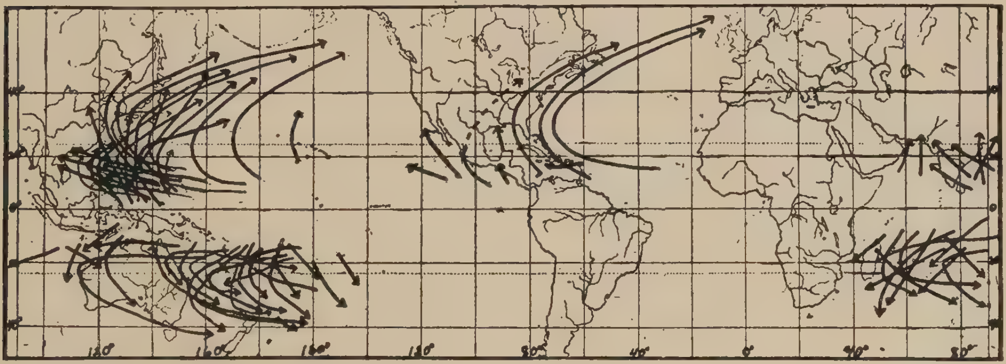

Figure 5.—Sketch map showing tracks of the tropical cyclones (hurricanes, typhoons, and gale-producing cyclones) of an average year. (Original.)

SHARP LOCAL CONTRASTS IN RAINFALL

A fourth feature of the rainfall conditions in the tropics which interferes with tropical development is its relative localization. In many parts of the tropics there are such sharp local contrasts as to interfere seriously with land utilization. In many areas where the relief is not more than a few hundred feet, one place receives more than twice as much rain as another place close at hand. This is especially true where mountains are near, but it is also true in some regions which lack real mountains, northeastern Queensland and northeastern Brazil, for instance. The city of Honolulu may serve as an illustration: Within four miles from the central weather bureau station with its thirty-one inches of average rainfall are long, reliable records of less than twenty-five inches (in the lee of Diamond Head) and over ninety inches (nearer the mountains, but still almost at sea level).

Where sharp local contrasts in average rainfall obtain, the areas best adapted to a particular crop variety commonly are small and widely scattered, and it is hard to fit crop to rainfall type. The Hawaiian Sugar Planters Association, for example, is experimenting with several hundred varieties of cane in an effort to find the best variety for each combination of rainfall and soil. This is a tremendous undertaking for even so rich and scientific an organization, but is almost an impossibility for an individual, who can scarcely hope to find more than a fair fit. Similarly, dwellings, equipment, and methods that are satisfactory in one place often are misfits only a short distance away.

Wind Storms as Retarding Influences

Civilization is so frail that it is injured by strong winds. As wind storms are especially severe and widespread in the tropics, and as various conditions are unfavorable to preparation to withstand them, wind storms deter civilization there much more than in mid-latitudes.

THUNDERSTORM SQUALLS

According to C. E. P. Brooks, more than a thousand thunderstorms occur each day somewhere in the tropics. Most of them are more severe than the average thunderstorm in the United States, and many are accompanied by violent squalls, which are made the more powerful by the greater deluge of rain. The damage done to vegetation is suggested by the prevalence of ragged banana leaves, of partly lodged sugar cane, and of fallen trees across roads and trails. The lightning accompanying tropical thunderstorms is also often much more intense and terrifying than with our storms.

TORNADOES AND RELATED STORMS

Whirling winds often accompany severe thunderstorms and frequently, even in America, it is not easy to distinguish between such a whirl and a weak tornado. Such transition storms appear to be especially frequent in tropical Africa, but they are rather frequent in many other tropical areas. Full-fledged tornadoes, comparable to the average tornado of the United States, are also experienced in most tropical regions, including Australia, India, the East Indies, and South America. Violent dust whirlwinds of almost tornadic force are not very rare in the Sahara and other tropical deserts. Water spouts, tornadoes over the sea, or, in other cases, convectional disturbances related to dust whirlwinds, are fairly frequent in the tropics.

TROPICAL CYCLONES: HURRICANES AND TYPHOONS

Although the wind storms already mentioned are not by any means trifling, they affect only small areas, and hence are much less significant than the large tropical cyclones which commonly badly damage a belt a hundred miles wide and several hundred miles long.

The existence of violent tropical cyclones has been known for a long time: Columbus encountered one on his second voyage. Their severity and destructiveness have often been described. They kill every year or two, thousands of people in densely populated southeastern Asia and hundreds in the West Indian region. The property loss in the West Indies is millions of dollars a year, on the average. Repeatedly most of the homes in large areas are unroofed, or demolished. The crops grown in the stormier regions are increasingly those which recover soonest from wind damage. Cane, which largely recovers in two years, tends to replace bananas and coconuts which recover much more slowly. Jamaica, for some years the leader in bananas, lost leadership because for three successive years hurricanes did much damage. That tropical cyclones have deterred the spread of white man's civilization has long been realized. However, their importance as a deterrent has not been generally appreciated because they were thought to be much rarer than they are, and because various harmful effects, es-

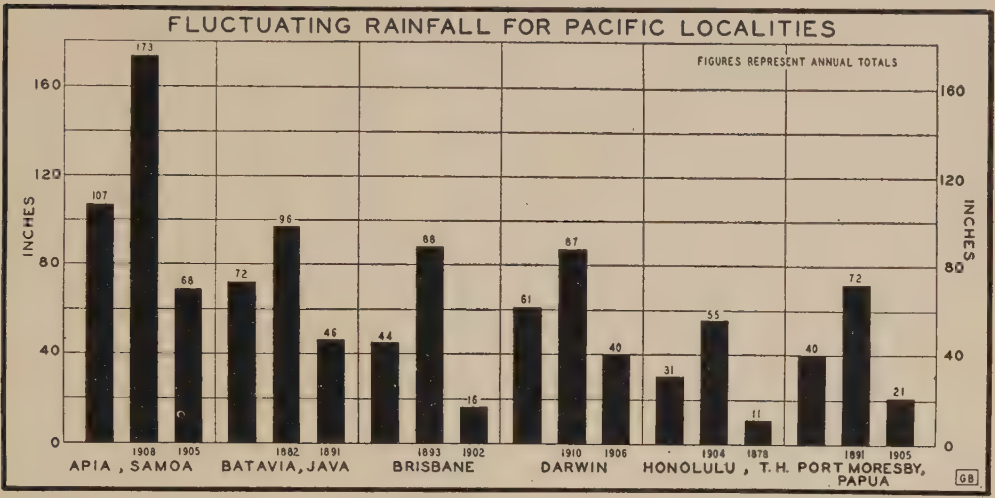

Figure 6.—Six cities upon the Pacific reveal the same wide fluctuations in climate as the rest of the cities of the world in the same kind of region. (Data mostly from World Weather Records, Smithsonian Institute, 1927.)

pecially indirect effects, were ignored. It therefore is appropriate that a brief statement be made as to their frequency and as to some usually ignored detrimental effects.

Instead of being rare phenomena, once in years, as many have assumed, upwards of forty hurricane-producing storms occur each average year somewhere in the tropics and perhaps twice as many gale-producing storms. The western Pacific has most, apparently having about one-half of the annual total of recorded storms. But, as the storminess of other sections of the tropics is studied, the predominance of the longer well-known western North Pacific decreases. For example, whereas in a treatise published in 1913, a summary of the tropical cyclones of the world ignored those of the southern hemisphere and showed the Far East as possessing nearly two-thirds of the world's tropical cyclones, data now available indicate that the typhoons of the Far East comprise less than one-third of the world's tropical cyclones.

On the average, about three hurricanes and two gale-producing cyclones occur yearly in the region of the West Indies, two hurricanes and three cyclones occur off the west coast of Mexico and Central America, two and four in the central North Pacific, thirteen and twelve in the eastern North Pacific, five and ten in the South Pacific, five and eight in Australia, eight and five in the South Indian Ocean and four and eight in the North Indian Ocean.

The approximate distribution of the tropical cyclones of an average year is shown in Figure 5. This sketch map shows no destructive cyclones very near the equator except in the Philippine region, because they occur there only rarely, not each average year. However, very severe cyclones are experienced occasionally almost under the equator in the Pacific and East Indian regions, and in Africa. Another necessary omission from this sketch map is the occasional storm which travels on a very abnormal course.

The harmful effects of tropical cyclones are by no means limited to the direct effects of the wind, the feature usually emphasized. Tropical cyclones caused most of the excessive rainfalls mentioned on an earlier page. During the four days required for a tropical cyclone to pass, eighty-eight inches of rain fell near Manila, in the Philippines, and 96.5 inches at Silver Hill, Jamaica (B. W. I.), and 77.3 inches at Cromhurst, Queensland, Australia. In three days, as a cyclone passed, 81.5 inches of rain fell at Funkiko, Formosa, Japan, and sixty inches at Mt. Molly, Queensland. There are numerous records of more than twenty-five inches of rainfall during the passage of a cyclone. Such downpours, besides causing serious floods, damaging roads, irrigation works, and railroads, erode the soil very badly on even gentle slopes. The heavy rain also influences the amount of uprooting of trees. Certain tropical trees, such as the coconut palm, usually can be bent until the top touches the ground, without breaking or uprooting. However, if the soil has been thoroughly soaked, uprooting is much more easily accomplished. The rapid run-off sometimes results in torrents sweeping down shallow depressions which rarely carry much run-off.

Another effect of tropical cyclones which is often overlooked is the great waves caused. Waves dash with great violence upon the shores and often reach heights of fifteen feet above normal sea level and not rarely twenty-five feet. There are, indeed, a number of records of hurricane waves reaching a height of forty feet above sea level. Harbors are often impaired by such waves, both by the damage to wharves and docks, and by the partial blocking up of the channel, by great blocks of coral, wrecked ships, or drifted sand.

The sudden coming of great waves drowns many people upon low coasts and along the lower stretches of river valleys. Sometimes, indeed, the water advances as a wall-like wave several feet in height, from which escape is very difficult. Most of the more than 30,000 persons destroyed by the Swatow, China, typhoon of August 3, 1922, drowned, as the general sea level rose eight feet, and great waves rolled over the lowlands, two reaching twenty-five feet above normal sea level. Drowning also caused the death of most of the 200,000 persons reported killed by the Calcutta hurricane of October 3, 1876.

The "mountainous" waves caused by the hurricane winds often damage ships, dashing over the decks, often sweeping away part of the equipment, such as lifeboats. The passage of high waves under the boat repeatedly exposes the propellers, causing them to "race" badly. Since the sudden speeding up of the propellers, when they are lifted into the air, and their equally sudden slowing down when they are again covered with water, subjects the machinery and engine to great strains, it is necessary to run the engine at greatly reduced speed, or even to shut down entirely when the waves are especially bad. Another way in which the waves injure ships is by wrenching them badly. Ships are sometimes broken in two by being suspended between two great waves, or by having the ends unsupported. Others are injured by having their engines and boilers displaced by the violent rolling and pitching of the ship and the shiftings of the cargo. Even the strongest boats are also likely to be driven ashore, if not far from land.

OTHER INDIRECT EFFECTS OF TROPICAL CYCLONES

Disastrous tropical cyclones unquestionably have tended to increase the inertia, fatalism, and communism of tropical peoples. Nothing is quite so deadening to ambition and so unfavorable to persistent effort as the conviction that one's endeavors are likely to be in vain. Devastating tropical cyclones have rendered in vain innumerable efforts. They help produce lassitude, "laziness," and carelessness because from time to time they make the hardest working individual or family as poor in worldly goods as the laziest. They also increase fatalism by their strange partiality. Some houses are destroyed while similar ones close at hand escape; some coconut trees are broken or uprooted while nearby ones survive; many persons are killed while others escape almost miraculously. These differences are mostly due to the varying strength of local gusts of wind or to differences in soil or run-off waters, none of which are apparent to most observers, and hence the result is to increase fatalism and superstition. Even rather intelligent whites have illustrated this to the author. One said: "If it is your turn, you will be caught anyhow, no matter what you do," and another, that he intended to sell out and leave the tropics soon, for he had noticed that "Whenever a white man tries to become very rich in the Pacific Islands, a hurricane comes along and makes him poor again." Communism is encouraged by the gratuitous redistribution of remaining property which is logical after a severe storm.

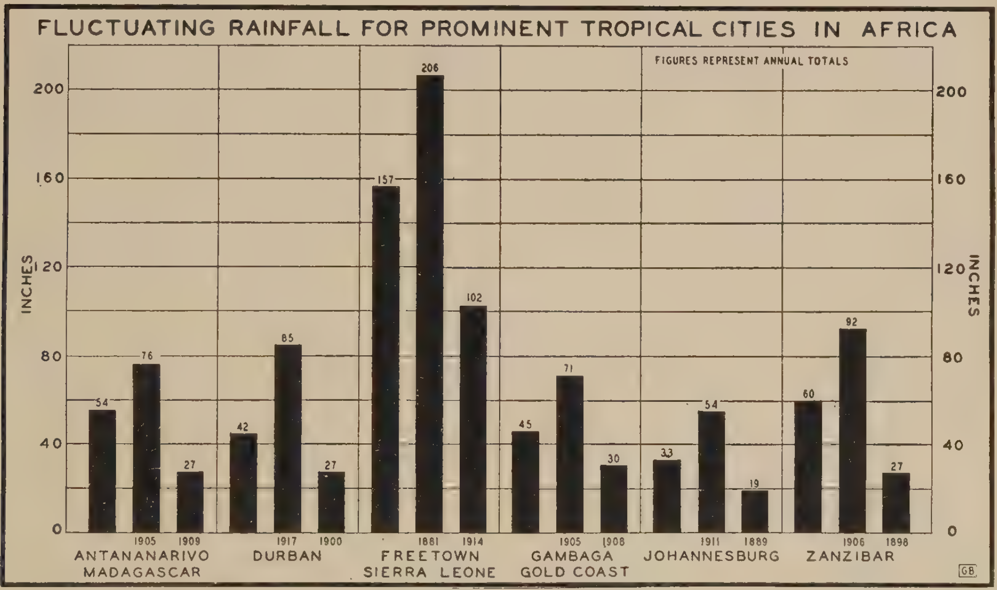

FIGURE 7.—If further evidence were needed of the wide fluctuations in tropical rainfall, the cities of Africa would furnish ample. (Data mostly from World Weather Records, Smithsonian Institute, 1927.)

The discouragement caused by destructive cyclones coöperates with other influences to create additional undesirable conditions. Instead of a well-balanced development with diversified agriculture and manufacturing for the local market, generally chiefly export products that are especially and quickly profitable are produced. Exploitation rather than wise utilization prevails. Also, instead of comfortable permanent dwellings, the tendency in areas often damaged by storms is to make cheap, temporary improvements. Instead of constructing expensive good roads, the tendency is to get along with cheap trails, for even the most carefully constructed roads are badly damaged by the torrential run-off characteristic of hurricanes. Bridges suffer correspondingly, and, as a result, commonly are mere makeshifts.

The white people of tropical regions frequently lament these conditions and try to improve them, but the pressure brought by distant investors and friends interferes. Investors in tropical regions demand large dividends partly because they fear storms, and hence do not approve of expensive improvements. Even strong local governments have great difficulty in borrowing at reasonable interest rates to make needed improvements and repairs to storm-damaged roads, bridges, and harbors, partly because of the uncertainty as to how long the proposed improvements will serve, before another storm demolishes them.

Disease is increased in several ways. Few people eat or sleep sufficiently while the "blow" lasts, often two or three days; their diet suffers long afterwards, because of the injury to food plants. Many thousands have died of starvation, or of diseases which in their weakened condition they were unable to withstand. Disease also increases with the mosquitoes that develop in the water holes, washed by the torrents produced by excessive rainfall. Healthfulness is affected also by the location and character of the houses, both of which often reflect the fear of storms.

HURRICANES AND THE RACE PROBLEM

The hurricanes have supplemented other conditions in discouraging sufficient white colonization to furnish the required tropical labor. Hence, white exploiters of tropical resources have imported negroes and later coolies from India, China, and Japan. Overpopulation of tropical lands by colored people has been encouraged by white overseers who, with few exceptions, are far more interested in securing cheap labor than in elevating the laborers. Cheap labor is conducive to large profits, and large profits are demanded by investors, partly because of the considerable hurricane risk. Overpopulation is encouraged by the high temperatures and ease of obtaining a mere livelihood; but it is also encouraged by the low property standards which prevail partly because of hurricanes. The gradual improvement of the home, and accumulation of equipment and small savings that have done so much to lead to a fairly high standard of living in mid-latitudes, are greatly discouraged in the tropics by destructive hurricanes, as well as by other causes.

CONCLUSION

Thus, it appears that the development of the tropics is rather seriously interfered with by certain rainfall and wind conditions, and that before the tropics can be developed advantageously, rainfall and wind conditions must be well known, and adjustments to them wisely worked out. Some adjustments which appear essential are: The location and construction of buildings so as to reduce their damage from floods and hurricane winds and waves to a minimum; storm, drought and flood warnings as far in advance as possible; insurance against unavoidable conditions; diversification of production; and the use of more capital and science. Obviously highly civilized man can cope with the numerous problems of the tropics far better than less advanced people. Indeed, the natives of the tropics have, unaided, made little progress. Hence, fuller utilization of the great tropical resources awaits carefully planned, well-financed, and concerted attempts by the people of mid-latitudes. Such attempts will be made when the tropics, in spite of their handicaps, afford greater opportunities for capital, labor, and intelligence than are available in middle latitudes. Large rich companies with widely separated holdings and a variety of products, for example, the United Fruit Company of the Caribbean region, have decided advantages over the individualist type of development. Indeed, it appears that such well-managed corporations offer the best prospects of successful development of the tropics, although mid-latitudes have been best developed by individuals. Unless extensive governmental aid is given, as in Queensland, relatively few individuals can cope successfully with the numerous difficult conditions in most of the tropics.

AGRICULTURAL REGIONS OF NORTH AMERICA

Part VIII—The Pacific Subtropical Crops Region

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THE Pacific coast is a unique part of North America—in mildness of climate, in magnificence of scenery, in majesty of forests, in kinds of crops grown, and, to a lesser extent, in the character of the people and their attitude toward life. Passing over the mountains from the hot Imperial Valley, occupying the Colorado River delta, with its cotton and cantaloupes, grown largely by aid of Mexican labor, to San Diego and Los Angeles, with their balmy and equable climate, their art and culture, is like going from Egypt to Italy. Likewise, climbing over the mountains from Reno, Nevada, to Sacramento and San Francisco, is almost like an airplane trip from Angora, Turkey, to Milan and Bordeaux, but briefer. Farther north, the traveler crossing the Cascade Mountains from the Yakima or Wenatchee valleys to the Puget Sound cities will find the change in climate as great as in going from Tashkent to Liverpool or Glasgow, but the trip requires only a few hours. Still farther north, traveling from Edmonton, Alberta, to Prince Rupert, British Columbia, is like a journey from Samara or Kazan, U. S. S. R., to the west coast of Norway.

The Pacific coast of North America, like the Atlantic coast of Europe, has a climate greatly influenced by the adjoining ocean; but, unlike Europe, a high and practically continuous mountain range restricts, largely, the marine influence to a narrow belt of land and makes the transition very abrupt. The winters along the Pacific coast are mild and moist, while the summers are cool and dry—cooler than in the eastern United States, except in the interior valleys of California which are very warm, and drier than in either the eastern United States or western Europe, owing to the low Coast Range precipitating a portion of the moisture in the ocean winds.

As a consequence, the crops along the Pacific coast are somewhat different from those in the Eastern States and more like those of Europe, particularly in the Pacific Subtropical Crops Region, which, in this respect, may properly be called the North American Mediterranean Region. One-third of the winter vegetables produced in North America, two-thirds of the oranges, over three-fourths of the grapes, prunes, and figs, and practically all the lemons almonds, and apricots are grown in this region. Also, like the Mediterranean Region, it is a great winter playground for many thousands of people from the colder Eastern and Northern States; and, much more than the Mediterranean lands, it is a region of retirement for those past the prime of life, particularly those who are financially able to spend their declining years in the snowless and sunny climate.

The Pacific Subtropical Crops Region is confined to the valleys of Central and Southern California, and

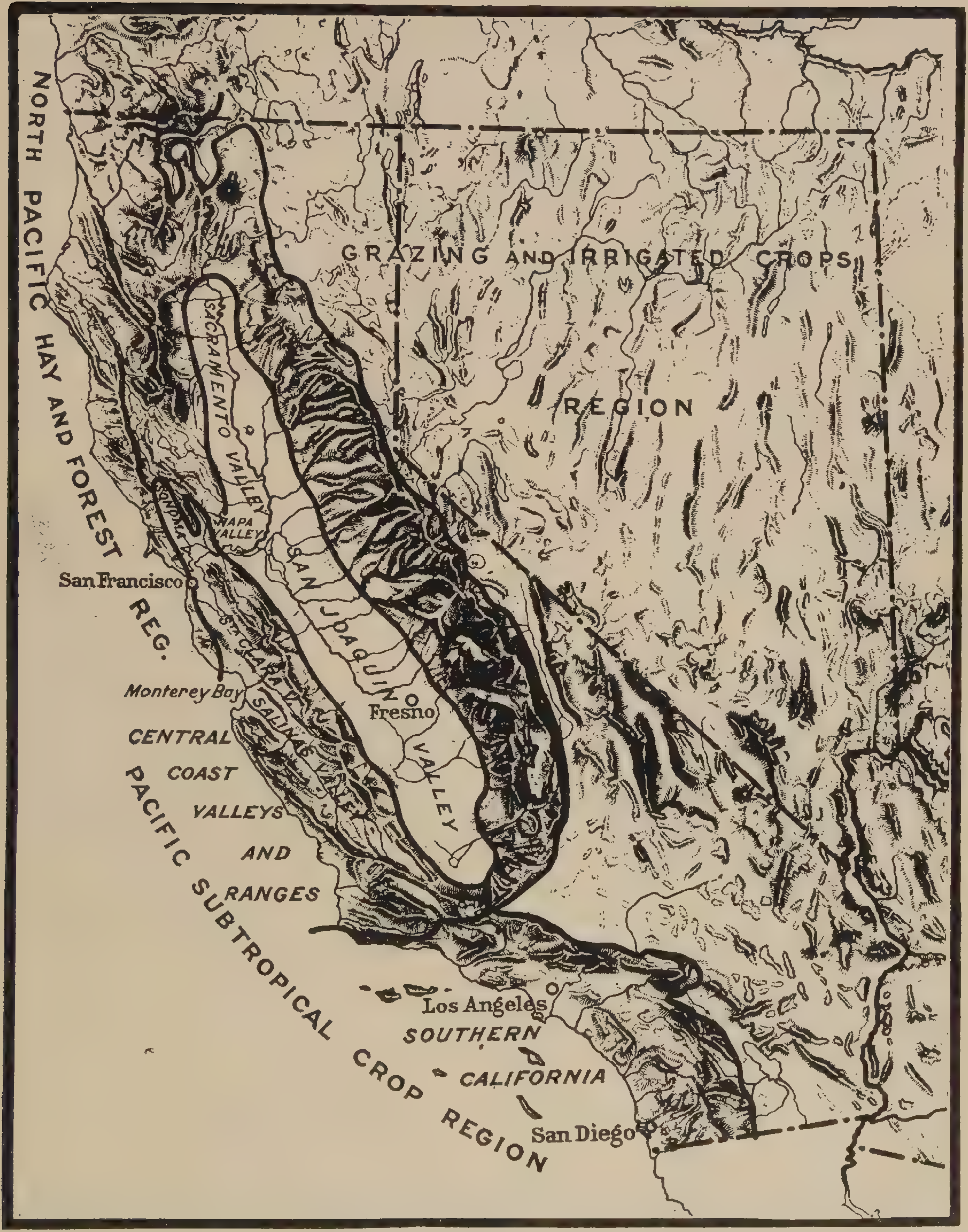
NORTH PACIFIC HAY AND FOREST REG.
GRAZING AND IRRIGATED CROPS REGION
SACRAMENTO VALLEY
SONOMA
NAPA VALLEY
San Francisco
SAN JOAQUIN VALLEY
Fresno
STA CLARA V.
SALINAS VALLEY
Monterey Bay
CENTRAL COAST VALLEYS AND RANGES
Los Angeles
SOUTHERN CALIFORNIA
San Diego
PACIFIC SUBTROPICAL CROP REGION

Figure 209.—The Pacific Subtropical Crops Region is confined to California, except for a small and mostly arid extension in the Lower California portion of Mexico. The region includes (1) the San Joaquin and Sacramento valleys, known jointly as the "Great Valley," (2) the valleys that drain into San Francisco Bay from the north and south, also the Coast ranges to the south of the Bay, the Salinas Valley, and the coastal plain and valleys from Santa Cruz to Point Conception, and (3) the coast, valleys and mountains of Southern California, but excluding the desert east of the mountains. The dominating influence of topography in determining the utilization of the land is further indicated by the fact that the mountains supply the water to irrigate the valleys and also exert a strong influence upon temperature conditions. The map is a photograph of a part of the hachure and drainage drawings for a base map of the United States prepared by F. J. Marschner for the *Atlas of American Agriculture*. The delicacy of the original drawing is obscured in the photograph.

includes also the Coastal Belt south of Santa Cruz. It is one of the smallest of the agricultural regions of North America, averaging about 125 miles wide, except that the northern and southern portions are narrower, and is 800 miles long (see Fig. 209). The total area of the United States portion is about 50,000,000 acres, but fully 10,000,000 of these are in the Coast Ranges, the San Gabriel, and other mountains. There are also about 5,000,000 acres in Mexico that have been classified with this region, but these lands are very dry, providing little else than desert range for cattle, and as no statistics are available concerning their agriculture, they will not be considered further.

Of the 40 million acres of land in the region, excluding the mountains and the desert, only 16 per cent was in crops, including orchards, in 1924, while practically all the remainder was used for pasture, including the one or two per cent of the land in woodland and the eight per cent in chaparral (semi-arid dwarf forest and brush). Despite this small proportion of the land in crops, the value of the crops per square mile of land area ($9,000 in 1919, the latest year for which complete figures are available) was greater than in any other agricultural region except the Corn Belt. Although crops occupy only one-fifth as great acreage as pasturage, their value is vastly greater than that of the pasturage.

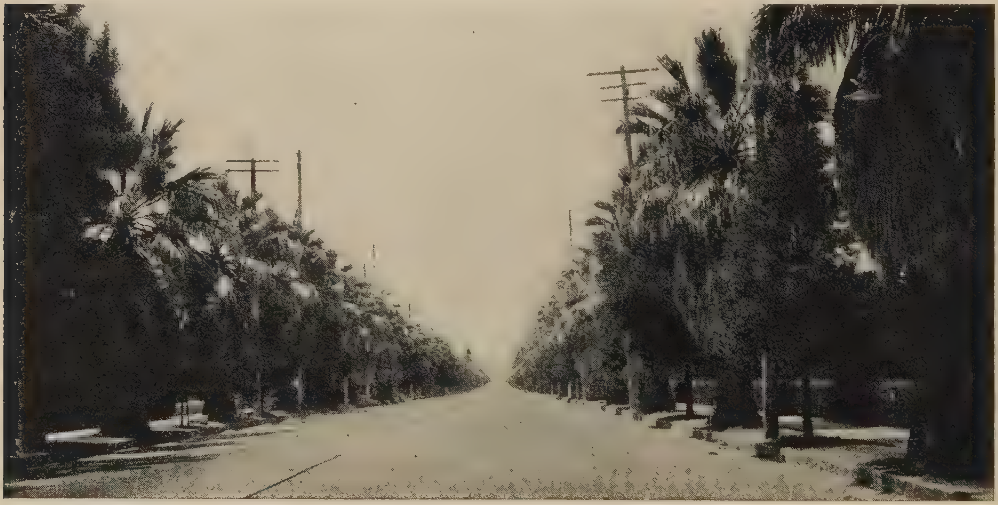

FIGURE 210.—Palms are grown for ornament in nearly all the valleys of the Pacific Subtropical Crops Region, but are more common in Southern California. In this section of California many streets are lined with fan-leafed palms, like this street in Redlands. (Photo from Prof. H. P. Gould, U. S. Bur. of Plant Industry.)

The Subtropical Crops Region is one of the most populous regions in the West. In 1920 its population was about 3,200,000, which has increased, probably, to 4,000,000 today. Although the region covers only about one-third of the land area of California, it includes over 93 per cent of the people of the state. The two largest cities in the West, Los Angeles and San Francisco, are located in this region, and these, together with many smaller cities, provide a market not only for much of the produce of the region, but also for some of the products from the Grazing and Irrigated Crops Region to the east.

Nevertheless, this Subtropical Crops Region ships out a larger proportion, probably, of its agricultural products than any other agricultural region in North America. Over 90 per cent of its oranges, lemons, grapes and raisins, prunes, peaches, figs, pears, and various vegetables, both fresh and canned, beans, cotton, and wool are sent to the Eastern or Northern States or to foreign countries. Only the milk and dairy products, the poultry and eggs, the meat, and the grain and hay are consumed mostly within the region.

The region produced crops in 1919 having a farm value of about $550,000,000, but owing to the fall in prices the value is probably somewhat less today, despite a notable increase in production. This value of the crops in 1919 was less than four per cent of the total value of crops in the United States, but these were grown on an acreage less than two per cent of the total in the nation. The average value of the crops per acre was nearly $100 in that year, as compared with $40 for the nation as a whole. About half of the value of all crops in the region consisted of fruits and nuts. Vegetables in 1919 totaled only one-tenth of the value of all crops, but the proportion is doubtless higher today. In no other region do fruits constitute so large a proportion of the value of all crops, and only in the Middle Atlantic Trucking Region are vegetables as important. The influence of the oceans, which moderate the winter temperatures, appears to be the dominant factor in determining the utilization of the lands in both these regions, but a contributory factor is the growth of large urban populations along these eastern and western coasts of the continent. The Pacific Region, in addition, has a bulwark at its back—the Sierra Nevada and San Bernardino Ranges, which shield the California Valleys from the low winter temperatures of the arid interior region.

In addition, to fruits and vegetables, hay, principally alfalfa and grain cut green, and the cereals, principally barley, are important, contributing jointly about one-third of the value of all crops. Indeed, the acreage of the hay crops is greater, and of grain crops is almost equal to the acreage in fruit. But, the value of the fruit crops per acre ranges from six to ten times that of the hay and grain crops. Sugar beets, beans, and cotton are also important crops locally.

PHYSICAL CONDITIONS

The northern end of the Subtropical Crops Region is 800 miles north of the southern end, yet the same crops are or can be grown throughout the region. Palms are grown for ornament nearly everywhere, and orange orchards are found on the foothills near the northern end of the region as well as in the southern portion (Figs. 210 and 228).

BOUNDARIES

The eastern boundary of the region is set by the Sierra Nevada Range, including the Tehachapi, and by the mountain ranges in Southern California. On the west also the region is bounded by mountains as far south as Monterey Bay. These mountains, like the Sierra Nevada, were more or less clothed with forest as far south as this bay. In general, the Subtropical Crops Region was originally grassland, and the boundary line along the various mountain ranges has been drawn commonly where the grassland or open oak stands of the valleys give place to heavy chaparral or coniferous forest. This brushland or forest edge marks also in some places the edge of the valley bottom, in other places the upper edge of the rolling foothills. It commonly coincides with a sharp break in the topography (Fig. 211).

Included in the region are the Coast Ranges south and east of San Francisco and Monterey Bays. Some of these have a few coniferous trees on their summits, and along the immediate coast for several miles south of Monterey Bay redwood trees are found in moist coves. But, except for these few moister spots, the region is not forested. This distinguishes it from the North Pacific Hay and Pasture Region, which is forested, except in a few valleys. In addition, the Subtropical Crops Region has a milder, Mediterranean type of climate.

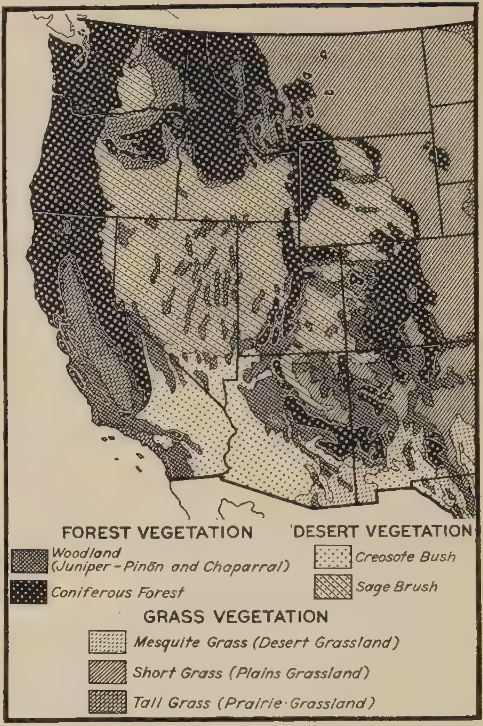
FOREST VEGETATION
Woodland (Juniper-Pinōn and Chaparral)
Coniferous Forest
DESERT VEGETATION
Creosote Bush
Sage Brush
GRASS VEGETATION
Mesquite Grass (Desert Grassland)
Short Grass (Plains Grassland)
Tall Grass (Prairie·Grassland)

FIGURE 211.—The original vegetation in most of the valleys in the Subtropical Crops Region was probably California bluegrass and needle grass, but this has been modified by grazing to a final stage of red brome and other bunch-grasses, with which are mixed many flowering plants. On the adjoining hills is usually a belt of chaparral or live-oak, with coniferous forest on the higher mountains. (Map generalized from *Atlas of American Agriculture* map by Zon and Shantz, 1921 Yearbook, U. S. Dept. of Agr.)

CLIMATE

The region, as the name indicates, has a subtropical climate. Frost has been reported in every portion, but it is commonly not severe, the temperature in the foothills and bench lands seldom falling below 26 degrees, which is as low as citrus trees will stand for a few hours without injury under normal conditions of humidity. A frost that will kill tender garden vegetables, such as tomatoes, occurs nearly every year, except around the shores of San Francisco Bay and in parts of the lower Sacramento Valley, also along the coast south of San Luis Obispo, and on the foothills of the valley from Los Angeles east to Redlands and Riverside. However, it is seldom that frost occurs anywhere in the region after April 1 (except in the Delta district of the Sacramento and San Joaquin Rivers), nor before November 1. The average duration of the frost-free season is, therefore, over 240 days in nearly all portions of the region, except in the mountains, and in the low-lying "pockets" into which the cold air flows at night. In much of the region the frost-free season exceeds 270 days.

Because of this accumulation of cold air in the lower lands, the citrus trees, almonds, and other fruits sensitive to frost are commonly grown on the alluvial fans or foothills, where the night temperatures normally are higher and the day temperatures lower and less stimulating to early bloom than in the valley bottoms. Even on these higher lands artificial heat is sometimes required, notably when "northers" blow in from high pressure areas to the north or northeast (Fig. 212). Even when not injuriously cold, these high winds occasionally do serious damage by stripping fruit from the trees. The bottom lands are used mostly for the hay and grain crops and for the hardier fruits and nuts, or else only for pasture.

Although the winters are almost free from freezing weather, the winter temperatures are cool and similar throughout the region, averaging about 50 degrees. On the other hand, the summer temperatures vary widely in the different districts. The coast is normally cool in summer, both night and day, the temperature ranging from 50 or 55 degrees in San Francisco at sunrise to 65 and occasionally 70 degrees in the afternoon, while at San Diego, near the Mexican Boundary, the sunrise temperatures are usually 60 to 65 degrees, and the afternoon maxima 70 to 75 degrees. In the Sacramento and San Joaquin valleys, on the other hand, the average summer temperature ranges from 50 or 60 degrees in the early morning to 90 or 100 degrees in mid-afternoon, except in the Delta district and inland as far as Sacramento, which are reached by ocean winds from San Francisco Bay. Likewise in Southern California, while Long Beach averages 79 degrees daily maximum temperature in July, Riverside, less than 50 miles inland, but behind a low range of mountains, averages 93 degrees. In nearly all the interior valleys of the Pacific Subtropical Crops Region temperatures exceeding 100 degrees occur frequently in the summer. Fortunately, the nights are cool, the minimum temperature normally falling below 70 degrees throughout the region, and the nearby coast is still cooler. As the roads are good, it is customary for many families living in the interior valleys "to Sunday" on the coast.

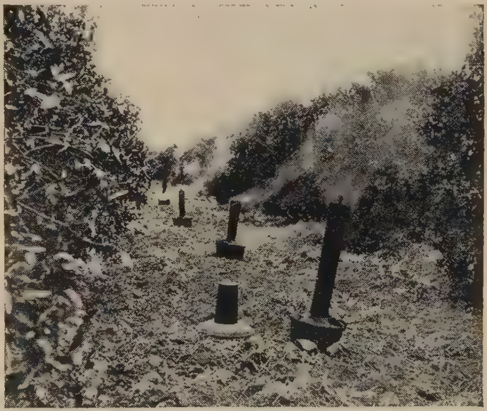

FIGURE 212.—No part of the Pacific Subtropical Crops Region is frost-free, and although certain sites are well adapted to citrus fruit, it has proven possible on other sites to reduce the injury to fruit by freezing, and avoid the much more serious injury to the trees, by using orchard heaters. These usually burn oil, and are placed as thickly as one to a tree where the orchard is a very valuable one. Thermostats located in the orchard are set to ring a bell in the farmer's house when a temperature of 28 or 30 degrees is reached, and then all the family and any others that can be employed rush through the orchard lighting the fires. The object is to keep the temperature above 28 degrees until the sun rises and never let it go below 26 degrees, as this degree of cold will injure the fruit. (Photo by Los Angeles Chamber of Commerce.)

The rainfall régime of the region is also both characteristic and variable. The first rain after the summer drought usually occurs in October, sometimes a couple of weeks earlier in the northern than in the southern portion of the region. The rainfall increases during November, when an inch or more of water is likely to be received, and reaches a maximum of 3 to 6 inches in January or February.

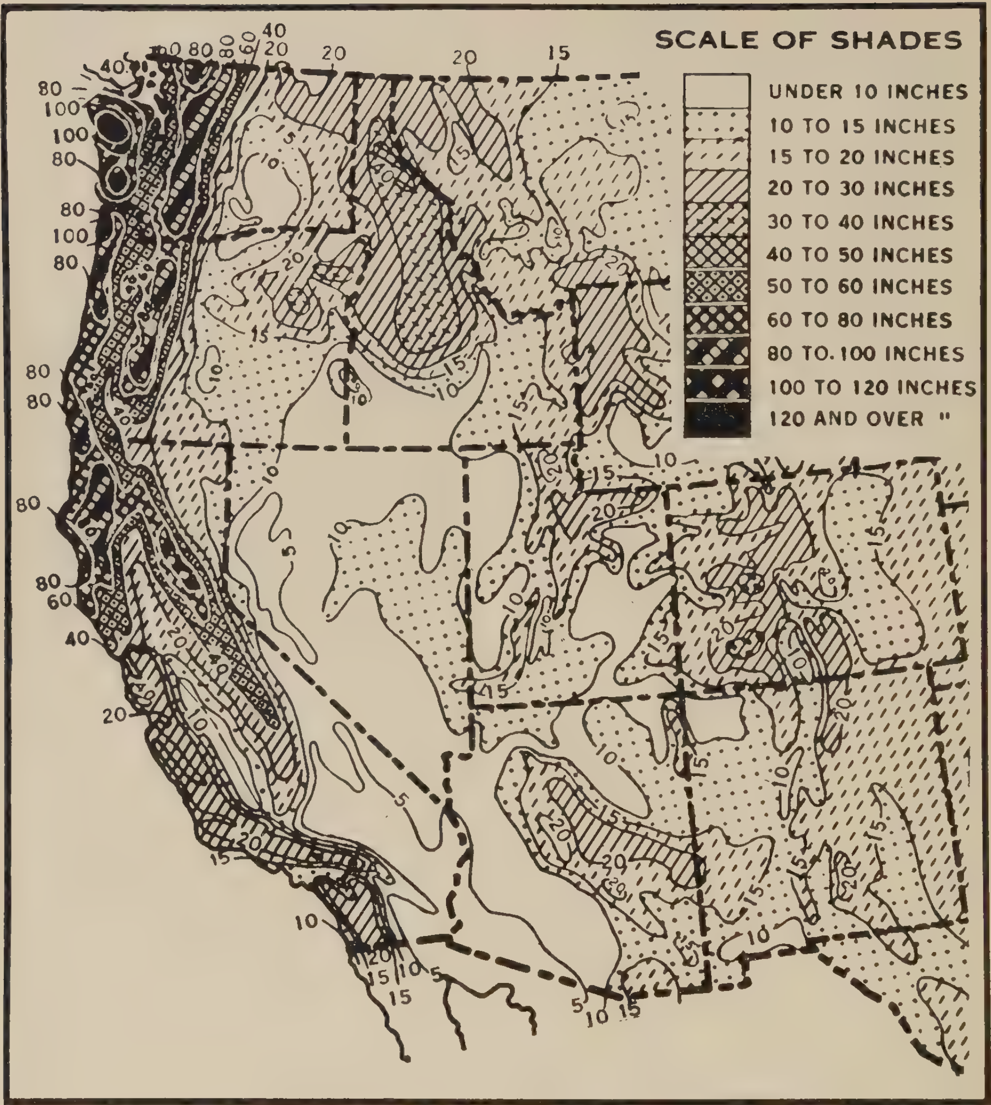
SCALE OF SHADES
UNDER 10 INCHES
10 TO 15 INCHES
15 TO 20 INCHES
20 TO 30 INCHES
30 TO 40 INCHES
40 TO 50 INCHES
50 TO 60 INCHES
60 TO 80 INCHES
80 TO 100 INCHES
100 TO 120 INCHES
120 AND OVER "

FIGURE 213.—Average annual precipitation. The yearly rainfall in the Subtropical Crops Region is mostly between 10 and 30 inches. Much of the west side of the San Joaquin Valley and a little of the coast near San Diego have less than 10 inches, on the average; while in the extreme upper Sacramento Valley and on the higher mountains in Southern California the rainfall is 30 inches and even more. Practically all of the agricultural area receives between 10 and 25 inches of rain in the normal season. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

The rains then normally become less frequent until April or May, varying with the locality, after which no rain may be expected, except in the mountains, until October. But, along the immediate coast heavy fogs often occur even during the summer, and these appear to provide a little moisture for the crops, notably the bean crop in Ventura and Orange counties. The fogs also raise greatly the relative humidity and reduce evaporation.

The average annual rainfall in the region is, of course, much heavier in the mountains than in the valleys, and is also heavier in the Sacramento Valley than in the San Joaquin (Fig. 213). It is somewhat heavier also along the eastern side of the Great Valley beneath the Sierra Nevada than along the western side of the valley in the "rain shadow" of the Coast Ranges. In most of the San Joaquin Valley the annual rainfall averages less than 15 inches, and in much of the valley is less than 10 inches. In the Sacramento Valley it increases from 15 inches at the southern end, where it adjoins the San Joaquin, to 30 and even 40 inches locally at the extreme northern end. In the San Francisco Bay district the annual rainfall ranges from 15 to 30 inches, and is even heavier in the upper Sonoma Valley. The Salinas Valley and Monterey Bay districts average about 20 inches of rain annually; while in the Los Angeles area, extending eastward to San Bernardino and Banning, the rainfall ranges mostly from 10 to 20 inches. Along the coast at San Diego it falls below 10 inches. In the mountains a few miles east the rainfall exceeds 25 inches, and on Mounts San Jacinto, Grayback, San Bernardino, and San Antonio ("Old Baldy") there is reported to be from 10 to 20 feet or more of snow in the normal winter, while showers occasionally occur even in mid-summer (as the writer knows by unpleasant experience).

These heavy snows in the mountains provide water for irrigation in the valleys the following summer, and in seasons when the snows are light the water may be short the following summer. Nowhere has there been more skillful development of water by wells in the alluvial fans and "washes" at the base of the mountains, and by the construction of subterranean dams in the gravelly stream courses, as well as by reservoirs in the mountains. And nowhere is irrigation water conserved more carefully. In Southern California nearly all the water is conveyed by covered concrete pipes or conduits to reduce evaporation, and open canals with earthen walls, such as are common in most western states, are almost unknown. The water is too valuable to lose by seepage. In the Great Valley, where water is less valuable, canals are common.

However, not all the crops, even in Southern California, are irrigated. Most of the cereal crops in the Pacific Subtropical Crops Region are grown in the winter months and depend on the natural rainfall. The almond orchards, and about half of the walnut, grape, and fig acreage, according to the census, are commonly not irrigated. Only 40 to 50 per cent of the prunes, pears, cherries, and apricots, and about 25 per cent of the apple acreage are irrigated. In general, from one-third to two-thirds of the acreage in the various vegetables is irrigated. On the other hand, most of the alfalfa, nearly all of the cotton, and all of the citrus fruit and rice are irrigated. The total irrigated area in the region in 1919 (the last year for which data are available) was about 3,500,000 acres, which was about 60 per cent of the acreage in crops (Fig. 214). Owing to the decrease in acreage of dry-land crops between 1919 and 1924, indicated by the census, and a probable slight increase in irrigated area, it is likely that today about two-thirds of the crop acreage of the region is irrigated.

It is evident, therefore, that the agriculture, particularly the horticulture, of the Pacific Subtropical Crops Region is based largely on the

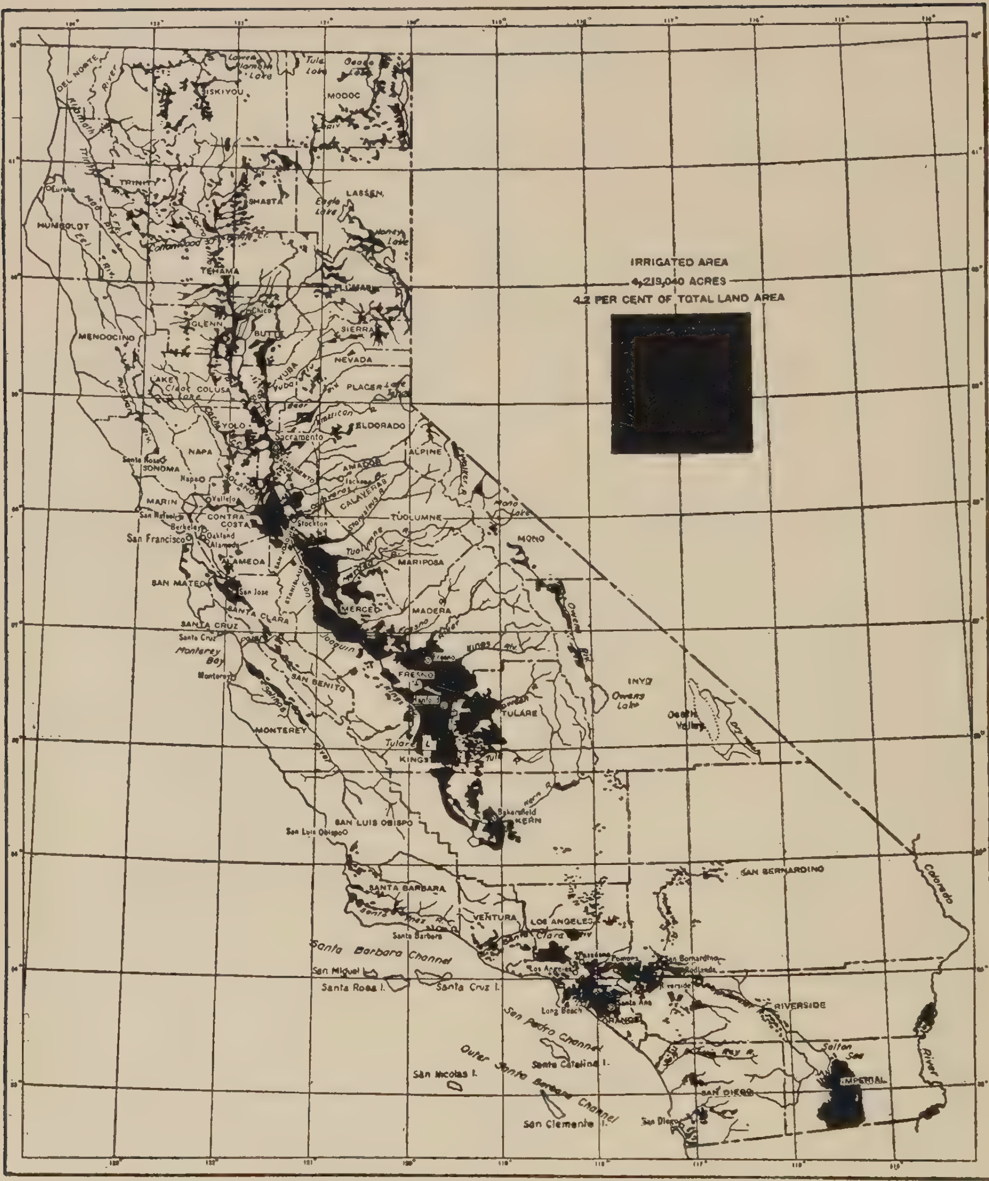
IRRIGATED AREA
4,219,040 ACRES
4.2 PER CENT OF TOTAL LAND AREA
DEL NORTE
SISKIYOU
MODOC
Tule Lake
Goose Lake
Klamath
TRINITY
SHASTA
LASSEN
Eagle Lake
Honey Lake
HUMBOLDT
Eureka
TEHAMA
PLUMAS
GLENN
BUTTE
Chico
SIERRA
NEVADA
MENDOCINO
LAKE
COLUSA
YUBA
PLACER
SUTTER
YOLO
Sacramento
ELDORADO
ALPINE
NAPA
SONOMA
Santa Rosa
Napa
SOLANO
AMADOR
MARIN
Vallejo
San Rafael
CONTRA COSTA
Berkeley
Oakland
Alameda
San Francisco
ALAMEDA
Stockton
CALAVERAS
TUOLUMNE
MONO
Mono Lake
MARIPOSA
SAN MATEO
San Jose
SANTA CLARA
SANTA CRUZ
Santa Cruz
Monterey Bay
Monterey
MERCED
MADERA
San Joaquin
Kings R.
Fresno
FRESNO
SAN BENITO
INYO
Owens Lake
Owens R.
Death Valley
TULARE
MONTEREY
Salinas R.
Tulare L.
KINGS
Kern R.
Bakersfield
KERN
SAN LUIS OBISPO
San Luis Obispo
SAN BERNARDINO
Colorado R.
SANTA BARBARA
VENTURA
LOS ANGELES
Santa Clara R.
Santa Barbara
Santa Barbara Channel
San Miguel I.
Santa Rosa I.
Santa Cruz I.
Pasadena
Pomona
San Bernardino
Redlands
Los Angeles
Riverside
RIVERSIDE
Long Beach
Santa Ana
ORANGE
San Pedro Channel
Salton Sea
Outer Santa Barbara Channel
Santa Catalina I.
San Nicolas I.
IMPERIAL
SAN DIEGO
San Clemente I.
San Diego

FIGURE 214.—Approximate location and extent of irrigated land in California. There were about 3,500,000 acres of irrigated land in the Pacific Subtropical Crops Region in 1919, of which 77 per cent was in the Great Valley, 18 per cent in Southern California, and 5 per cent in the Central Coast Valleys, principally the Santa Clara and Salinas. It will be noted that the San Joaquin Valley contains much more irrigated land (2,000,000 acres) than the Sacramento (640,000 acres), where the rainfall is heavier and a large proportion of the crops are grown without irrigation. (Map reproduced from Vol. VII of the Fourteenth Census, "Irrigation and Drainage," prepared largely by Ray P. Teele.)

extensive use of irrigation. Nowhere else in the United States has so much money been spent in overcoming the climatic conditions. But, it should be recalled that this money has been spent largely in an effort to take advantage of the favorable temperature conditions for the production of subtropical crops, grapes, and early vegetables. Here, as elsewhere, man's so-called conquest of nature consists essentially in modifying the disadvantage of one physical factor in order to take advantage of another factor, this modification being accomplished usually by the application of power in one form or another. In the case of irrigation this modification of the natural condition is being achieved at increasing cost per acre as the more feasible projects are developed. The physical conditions in a region are like a spring which yields under pressure, but as the pressure is increased, the resistance becomes proportionally greater, until eventually the point is reached at which increased pressure becomes unprofitable. This point appears to have been reached with reference to irrigation in most parts of the West. Indeed, the agriculture of the United States as a whole is now at that stage where it is generally more profitable to increase the yield per acre than to increase the acreage. The climate is still unmodified by man on 90 per cent of the land of the Pacific Subtropical Crops Region. But, the 10 per cent of the land which the Californians have reclaimed from aridity is a great tribute to their skill and perseverence. In no other part of the world has there been a greater conquest, and it is fitting that they should be proud of it.

TOPOGRAPHY

The agricultural portion of the Pacific Subtropical Crops Region consists mostly of the valley bottoms and adjacent piedmont slopes, in general below 1,000 feet elevation. However, in the pass near Banning, about 100 miles east of Los Angeles, there is a considerable acreage of deciduous fruit, including apples, at an elevation of 2,600 feet, and in the San Bernardino mountains there are apple trees at over 4,000 feet altitude. With few exceptions, however, the mountains in the region are covered with oak brush or forest, whose principal function is to conserve the water supply, and in places also to provide pasture. Four of the mountain peaks, all located in Southern California, exceed 10,000 feet in altitude. In the Coast Ranges there are only a few points above 4,000 feet elevation.

The mountain ranges divide the region into three parts: (1) the interior Sacramento-San Joaquin, or Great Valley, (2) the coastal valleys and coast as far south as Point Conception, and (3) the Southern California valleys and coast (Fig. 209).

The Great Valley is a structural trough between the Sierra Nevada on the east and the Coast Ranges on the west, enclosed at the north end by the Klamath Mountains and at the south end by the Tehachapi, and filled with rock-waste and sediments mostly from the Sierra Nevada. It is over 400 miles long and 40 to 50 miles in width, with an opening a little north of the center through the Coast Range to San Francisco Bay. The lands near this opening are marshy, and through the branching channels of the Sacramento-San Joaquin Rivers, boats from San Francisco navigate as far inland as Stockton and Sacramento. The floor of the Great Valley in general is a series of coalescing alluvial fans radiating from the mouths of mountain cañons, together with sediments deposited where the drainage has been obstructed. Such a fan-like rise of land about midway of the San Joaquin Valley diverts the drainage in the southern portion of the valley into Tulare and Buena Vista lakes, which are very shallow and are gradually drying up. The area of the Sacramento Valley is about 4,000,000 acres, of the San Joaquin nearly 8,000,000 acres, a total of nearly 12,000,000 acres in the Great Valley. Much of this land is tillable without irrigation and nearly all of it would be tillable if irrigated or drained. But, for permanent cultivation most of it will need to be both irrigated and drained.

The Central Coast and Valleys subregion includes (1) the valleys that drain into San Francisco Bay (excluding the Great Valley), principally the Sonoma and Napa on the north and the Santa Clara on the south, (2) the Monterey Bay coast and Salinas Valley, and (3) the San Luis Obispo-Lompoc district. The San Francisco Bay valleys and the Salinas Valley are structural troughs like the Great Valley, but much smaller. The San Francisco Bay valleys have a total area of possibly 1,000,000 acres, and there may be another million acres of valley land in the Salinas and other valleys north of Point Conception and along the coast, the surface of which is suitable for crops. It is barely possible that there are 2,000,000 more acres of rolling land in the foothills topographically available for crop production.[1] It seems very unlikely that there are more than 4,000,000 acres of tillable land in all this sub-region.

The Southern California sub-region consists principally of a narrow coastal plain and of the valley that extends eastward from Los Angeles to Redlands, including the San Fernando Valley and the Riverside and San Jacinto districts. The Los Angeles-Redlands Valley is another structural trough, and it is on the alluvial fans fringing this valley that most of the oranges and lemons are grown. Including the Riverside district and the San Fernando Valley, it may be roughly estimated to contain 1,200,000 acres of potentially arable land, to which should be added possibly 300,000 acres for the San Jacinto-Elsinore district. There may be another million acres of topographically tillable land along the coast, principally in Orange, Los Angeles, and Ventura Counties, and another half million acres in the valleys of San Diego County. The total area of potentially tillable land in this sub-region, including that now tilled, appears likely, therefore, to be about 3,000,000 acres.

In all the Pacific Subtropical Crops Region there is, apparently, only about 19,000,000 acres of topographically tillable land, nearly two-thirds of which is in the Great Valley. In other words, possibly one-third of the entire area of the region is tillable were water available, nearly one-half is upland too dry or else too steeply rolling for crop production, and one-sixth or more is mountainous. Of the 19,000,000 acres tillable less than 7,000,000 acres are at present under cultivation, or about one-third as much as in Illinois or in Iowa. The value of the crops, however, is probably as great as in either of these states.

SOILS

The soils in the Pacific Subtropical Crops Region are classified by the Soil Survey into (1) residual soils, or those derived from the weathering of consolidated rocks in place; (2) old valley-filling soils, which are derived from old weathered and otherwise modified unconsolidated, water-laid deposits; (3) recent alluvial-fan soils, which are derived from stream deposits that have undergone little, if any, change by weathering since they were laid down; (4) lake-laid soils; (5) wind-laid soils, or those owing their accumulation to wind action; and (6) miscellaneous soils, mostly rough broken land, tidal marsh, coastal beach, dune sand, and river wash.

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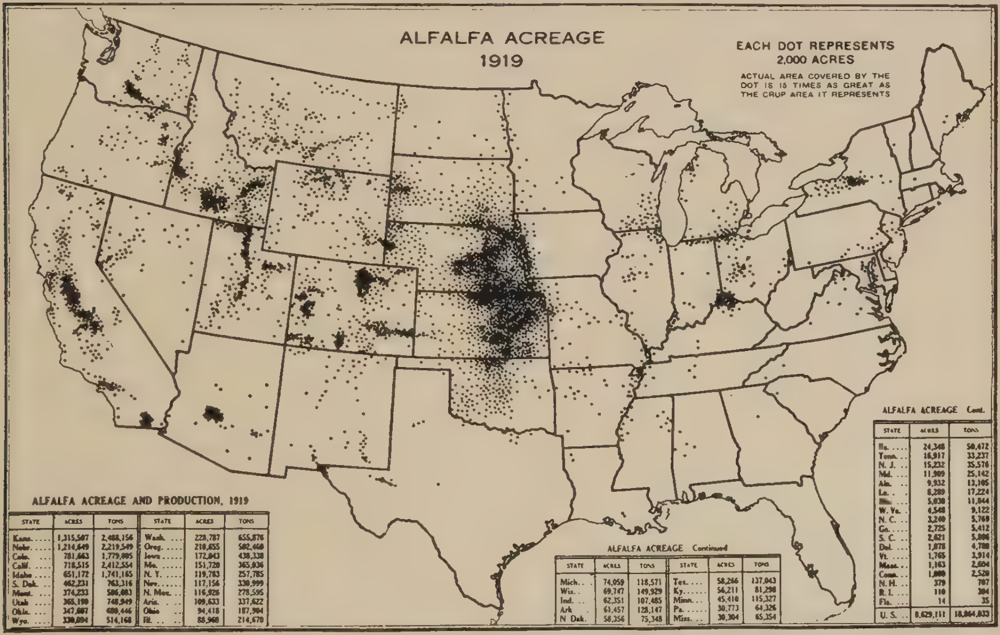
[1] Estimate based on "Reconnaissance Soil Survey of the San Francisco Bay Region," by L. C. Holmes and J. W. Nelson. Washington, 1917.

"The residual soils predominate in the hilly and mountainous regions; the old valley-filling soils prevail along the valley margins in the form of extensive fans and foot slopes, or elevated stream or marine terraces; and the recent alluvial soils form the lower parts of the valley floors or lie on the valley slopes influenced by recent stream deposits."[2] The lake-laid soils are confined to the flat shallow basin of Tulare and other lakes, and the wind-laid soils, which are not very extensive, are developed principally near the ocean beaches and in the drier parts of the region. Most of the valley soils belong to the old valley-filling and recent alluvial groups. The miscellaneous group of soils are practically all non-agricultural.

"The groups named are characterized by essential differences in character of soil and sub-soil material,


ALFALFA ACREAGE
1919
EACH DOT REPRESENTS
2,000 ACRES
ACTUAL AREA COVERED BY THE DOT IS 15 TIMES AS GREAT AS THE CROP AREA IT REPRESENTS

ALFALFA ACREAGE AND PRODUCTION, 1919

STATE	ACRES	TONS	STATE	ACRES	TONS
Kans.	1,315,507	2,488,156	Wash. ...	228,787	655,876
Nebr.	1,214,649	2,219,549	Oreg.	210,655	502,460
Colo. ...	781,663	1,779,805	Iowa	172,043	438,338
Calif.	718,515	2,412,554	Mo.	151,720	365,036
Idaho	651,172	1,741,165	N. Y.	119,783	257,785
S. Dak. ..	462,231	763,316	Nev.	117,156	330,999
Mont. ...	374,233	586,083	N. Mex. ..	116,926	278,595
Utah	365,190	748,949	Ariz. ..	109,633	337,622
Okla. ...	347,807	680,446	Ohio ..	94,418	187,904
Wyo.	330,094	514,168	Ill.	88,968	214,670

ALFALFA ACREAGE Continued

STATE	ACRES	TONS	STATE	ACRES	TONS
Mich. . .	74,059	118,571	Tex. ...	58,266	137,043
Wis. .	69,747	149,929	Ky.	56,211	81,298
Ind. ..	62,351	107,485	Minn. ..	45,410	115,327
Ark. .	61,457	128,147	Pa.	30,773	64,326
N Dak.	58,356	75,348	Miss. ..	30,304	65,354

ALFALFA ACREAGE Cont.

STATE	ACRES	TONS
Va.	24,348	50,472
Tenn. ..	16,917	33,237
N. J. ..	15,232	35,576
Md. ...	11,909	25,142
Ala. ..	9,932	13,105
La. . .	8,289	17,224
[illegible] ...	5,030	11,844
W. Va. .	4,548	9,122
N. C. ..	3,240	5,769
Ga.	2,725	5,412
S. C. ..	2,621	5,006
Del. ...	1,878	4,780
Vt.	1,765	3,914
Mass. ..	1,163	2,604
Conn. ..	1,000	2,520
N. H. ..	379	707
R. I. ...	110	304
Fla. ...	14	35
U. S. ..	8,629,111	18,864,033

FIGURE 215.—Most of the alfalfa in the Pacific Subtropical Crops Region is grown in the Great Valley, principally in the San Joaquin portion. In this valley both water for irrigation and land are more abundant and cheaper than in Southern California or in the valleys north and south of San Francisco Bay, which are given over largely to orchards—a more intensive use. There is, however, a considerable acreage of alfalfa in these valleys, grown mostly where irrigation water is readily available. About 1,000,000 acres are in alfalfa in the entire Subtropical Crops Region, producing normally 4,000,000 tons of hay. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

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[2] J. W. Nelson and others: "Reconnaissance Soil Survey of the Upper San Joaquin Valley, California, Field Operations of the U. S. Bureau of Soils, 1917." Washington, 1921.

topographic positions, age, chemical properties, and mode of formation. They are subdivided into groups called 'soil series,' each of which includes soils having certain common characteristics, such as color, character of sub-soil, origin, and other features, distinguishing it from other series in the same province. The types, or members of the series, are separated on the basis of texture, or the relative amount of sand, silt, and clay present.

"The residual soils . . . usually occur in hilly and mountainous positions. They are typically well drained. These soils vary greatly in depth, but the parent rock is usually encountered at less than 6 feet. . . . They contain varying amounts of rock out-crop, and are eroded or deeply furrowed in some places. The underlying rocks vary greatly in composition, origin, and topographic position. They are sedimentary, igneous, or metamorphic in character. Those of sedimentary origin are principally calcareous shales and sandstones with lesser amounts of conglomerate.[3]

"Soils derived from the old valley-filling or coastal-plain deposits are extensively developed in the region. They consist of elevated, unconsolidated, water-laid deposits which have undergone marked changes in soil and subsoil features since they were laid down. . . . They vary widely in color and mineral composition. Their heavy, compact soils and substrata are among the most important features which serve to distinguish them from soils of the other provinces. Some of the series in this group are marked by calcareous subsoils, others by gravelly substrata, and some by the presence of an indurated hardpan. . . . Their less well-aërated and permeable subsoils often make them less desirable for tree-fruits. The soils of this group along the ocean are characterized by their terraced position and frequently by an escarpment of 20 to 100 feet or more along the water front.

"The soils of recent alluvial origin are still in process of accumulation. They are very extensive in the valleys, and include the lightest colored and lightest textured soils. They have a smooth, uniform surface and permeable subsoils, in contrast to the higher and more uneven surfaced old valley-filling soils, with their heavy, compact, and poorly aërated subsoils." . . . In general "these are the most intensively developed soils of the region, and have a higher average value than any other group. Underground water for irrigation is available" in many places by pumping, especially "where these soils occur on the valley floor or along stream bottoms, but owing to the position and elevation of the more steeply sloping alluvial fans these areas have only a very scant water supply, which must be increased from outside sources if fruit and truck crops are to be grown under the most intensive management." A high water table sometimes is found in low-lying areas, and injurious amounts of alkali have occasionally accumulated locally.

"The soils of wind-laid origin are quite extensively developed" in several parts of the region. . . . "They have a ridged, undulating, or hilly topography and in some areas have been formed almost entirely by material drifted inland from the sandy ocean beaches. The soils are quite uniform, but usually become somewhat finer in texture with increased distance from the ocean. Drainage is good to excessive."[4]

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[3] "Soil Survey of the Los Angeles Area," by J. W. Nelson, C. J. Zinn, and others. Washington, 1919, pp. 22–23. In other areas the shales are not principally calcareous and various other sedimentary rocks are found.

Space does not permit a description of the soil series, nor to mention the soil types, but it should be noted that there are hundreds of different soils in the region and that these vary widely in their characteristics and their fertility. Although many of the soils, especially some of the recent alluvial and residual soils, are high in the mineral elements of fertility, owing to their youth and to the arid and sub-humid climate, they also tend to be very porous, while the older alluvial soils tend, on the contrary, to have either hardpan or relatively impermeable clay subsoils.

Nowhere else probably, except in Florida and the Atlantic Coastal Plain, are such poor soils used for crop production, and nowhere else has such careful study been given in fitting the crop to the soil. Recently much attention has been devoted also to problems of fertilization.

Agriculture in California is based on science and deduction from experience to a greater degree, perhaps, than in any other part of the nation. When one considers the difficulties of moisture and temperature, topography and soil that have been overcome, and the location of the region two to three thousand miles from its major markets, then views the evidence on every hand of the accumulation of a wealth and culture which is not surpassed elsewhere in the world, and realizes that this civilization has been erected within the brief span of 75 years, it seems fitting to pay this feeble tribute to the intelligence and perseverence of the people of this state.

LAND UTILIZATION

Eighty years ago, when California became a part of the United States, the region was almost wholly a cattle-ranching country, and even today apparently 60 per cent of the land is primarily devoted to grazing. But, from the standpoint of value of products, California is now primarily a crop production region—the outstanding fruit and vegetable growing region of North America. It appears probable that crops constitute nearly 90 per cent of the total value of agricultural production in the region, and that fruits and vegetables contribute fully half of this value.

The development of agriculture in California illustrates in striking manner many of the features that have characterized the trend of agricultural development in the United States as a whole. Two features in this trend stand out prominently: (1) Increasing production per acre and (2) increasing efficiency of labor.

INCREASING PRODUCTION PER ACRE

Crop acreage in California increased for many years, but between 1919 and 1924 decreased according to the Census.[5] In 1879 there were about 3,300,000 acres of crops harvested (including an estimated figure for acreage of fruit trees based on the number of trees), in 1889 the acreage had increased to nearly 5,400,000, and by 1899 it had risen to 7,000,000 acres. But, in 1909 it had fallen to 5,700,000 acres, or nearly to the 1889 level, and after a recovery to almost 6,900,000 acres in 1919, the crop area harvested in 1924 was again only about 5,700,000 acres. The decrease in total crop acreage harvested in the United States between 1919 and 1924 was about 4 per cent, whereas in California it was nearly about 18 per cent. However, 1924 was a very dry year in California and there were nearly a million acres of crop failure reported. The acreage of crop failure in 1919 is unknown, but was undoubtedly much less than in 1924.[6]

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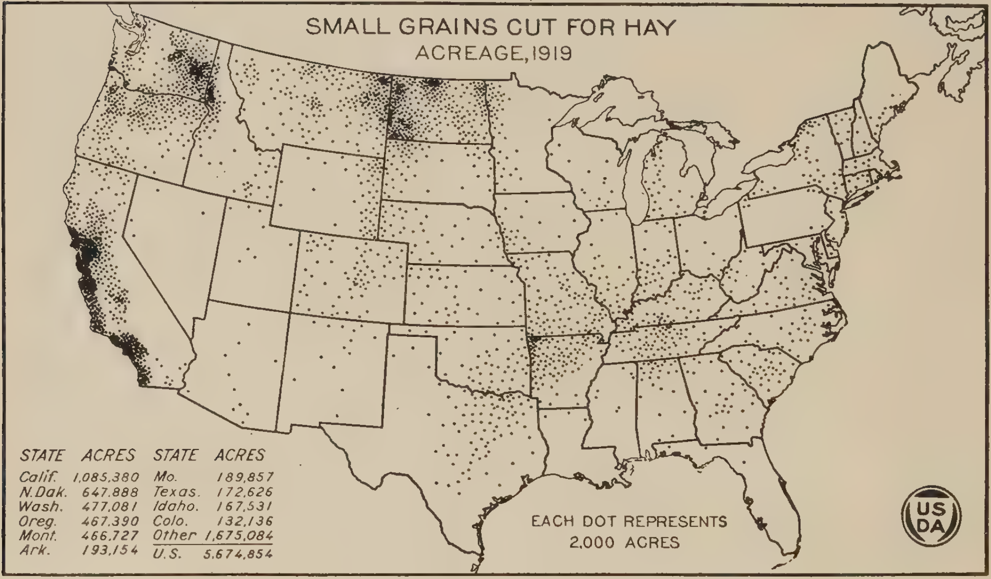
[4] "Soil Survey of the Los Angeles Area," by J. W. Nelson, C. J. Zinn, and others. Washington, 1919, pp. 24–29.

[5] In order to avoid laborious statistical tabulations by counties, the changes since 1880 (when the Census first enumerated acreage) in land utilization in California as a whole will be considered. As the Subtropical Crops Region includes about 94 per cent of the crop land of the state, any error resulting is unlikely to be serious.

In 1924, according to the Census, nearly 1,700,000 acres of plow land lay idle or fallow in California. As the acreage of summer fallow in the State is not large, it appears that most of this land lay idle. A similar condition exists in many parts of the United States. If only the crop acreage were considered, the conclusion would be clear that agriculture in California was declining. Instead, production has greatly increased, as will be shown later.



STATE	ACRES	STATE	ACRES
Calif.	1,085,380	Mo.	189,857
N.Dak.	647,888	Texas.	172,626
Wash.	477,081	Idaho.	167,531
Oreg.	467,390	Colo.	132,136
Mont.	466,727	Other	1,675,084
Ark.	193,154	U.S.	5,674,854

FIGURE 216.—Most of the grain hay in the region, unlike alfalfa, is grown in the Central Coast Valleys and in Southern California. There is sufficient rainfall during the winter in most of these subregions to produce a crop of hay without irrigation, and the small grains endure the frosts of winter without serious injury. The grain is cut in the spring while in the milk stage and makes a nutritious hay. Barley is the principal grain cut for hay, but wheat, oats, and rye are also used. The area of grain hay in the region averages now only about 600,000 acres, and the production 800,000 tons. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

Concentration of Capital and Labor on the Better Land

The figures of irrigated area show a very different trend—1,000,000 acres in 1890, 1,400,000 acres in 1900, nearly 2,700,000 acres in 1910, and 4,200,000 acres in 1920. Whereas total crop acreage decreased slightly between 1900 and 1920, irrigated acreage increased nearly 200 per cent. In 1899 only 20 per cent of the crop acreage was irrigated, in 1919 about 60 per cent. As previously noted, probably two-thirds of the crop acreage is irrigated today. Complete data are not available since 1920. As the irrigated land is, in general, more level or more fertile than non-irrigated, it is clear that capital is being concentrated on the more productive land.

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[6] The estimates of the California Coöperative Crop Reporting Service indicate an increase in total crop area of over 1,100,000 acres between 1924 and 1928. But, the value of the 1928 crops was only a little more than that of 1924. In 1929 production has been much less, but the sale value of the crops will be much greater than in 1928.

Labor also is being concentrated on the better land. Each successive census has shown an increase in the number of farms or farmers. The number doubled between 1880 and 1900, and almost doubled again between 1900 and 1925. The quantity of hired labor employed on farms (as estimated by the expenditure for labor divided by the average wage) likewise has increased. It almost doubled from 1899 to 1909, but increased, apparently, only about 10 per cent between 1909 and 1919, and about 25 per cent between 1919 and 1924.

Obviously the decrease in crop acreage and increase in number of farms has resulted in a decreased acreage of crops per farm. In 1889 the average farm in California had about 96 acres of harvested crops, in 1909 only 65 acres, and in 1924 about 42 acres.

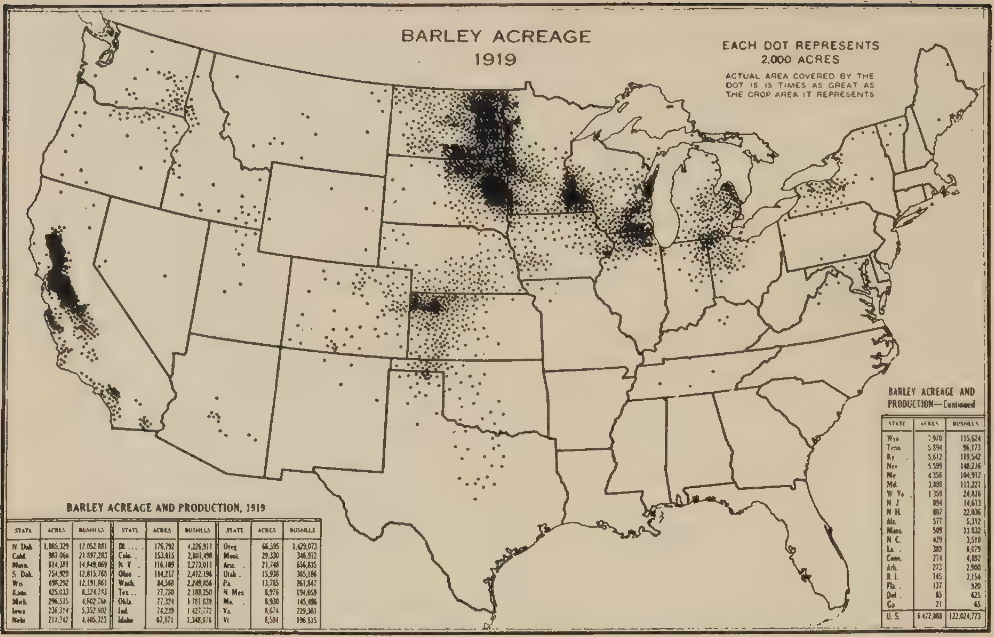
Shifts in Systems of Farming

This concentration of labor and capital on a smaller acreage has involved a shift in the system of farming—from wheat, barley, and beef production to fruit and vegetables, dairying and poultry. The area in wheat has fallen from nearly 2,700,000 acres in 1899 to only 360,000 acres in 1924, barley from 1,200,000 acres in 1909 to 750,000 in 1924, hay from 2,500,000 acres in 1909 to about 1,800,000 in 1924. However, the proportion of this hay acreage which is alfalfa has increased from less than one-fifth to over two-fifths in the fifteen years, and the nutritive value of the total hay production today is probably as high as ever before.

Changes in Production of Animal Products

Despite this contraction in acreage of barley and hay, the production of animal products in California is apparently greater than ever before. Doubtless this is owing in part to the increasing acreage of alfalfa. Between 1919 and 1924 the number of milk cows increased 11 per cent and the production of milk 23 per cent, according to the Census. This is a considerably greater gain, probably, than the increase of population in the State. Between 1919 and 1924 the average annual production of milk per cow increased nearly 65 gallons, or about 12 per cent. It is probable that the increase in production of milk per unit of feed consumed has been one-third to one-half as great as this increase in production of milk per cow.

The number of beef cattle has declined slightly since the war period, and of hogs notably, but the change in production of beef and pork is not known. On the other hand, there has been a great increase in the number of sheep. From 1900 to 1922 the number of sheep in the state remained more or less constant, but from 1922 to 1928, the number increased over 40 per cent. The number of chickens on farms January 1 increased nearly 23 per cent between 1920 and 1925, while the number of eggs produced increased 53 per cent according to the Census returns. The increase in production of eggs


BARLEY ACREAGE
1919
EACH DOT REPRESENTS
2,000 ACRES
ACTUAL AREA COVERED BY THE DOT IS 15 TIMES AS GREAT AS THE CROP AREA IT REPRESENTS

BARLEY ACREAGE AND PRODUCTION, 1919

STATE	ACRES	BUSHELS	STATE	ACRES	BUSHELS	STATE	ACRES	BUSHELS
N. Dak.	1,085,329	12,052,881	Ill.	176,792	4,226,911	Oreg.	66,595	1,429,073
Calif.	987,066	21,897,283	Colo.	153,015	2,801,498	Mont.	29,330	346,972
Minn.	814,381	14,849,069	N. Y.	116,109	2,273,011	Ariz.	21,748	656,835
S. Dak.	754,929	12,815,768	Ohio	114,217	2,412,196	Utah	15,938	365,186
Wis.	498,292	12,191,861	Wash.	84,568	2,249,856	Pa.	13,785	261,847
Kans.	425,033	8,324,793	Tex.	77,780	2,188,250	N. Mex.	8,976	194,059
Mich.	296,515	4,502,766	Okla.	77,324	1,781,639	Mo.	8,930	145,496
Iowa	236,314	5,352,502	Ind.	74,239	1,427,772	Va.	8,674	229,301
Nebr.	211,242	4,405,323	Idaho	67,873	1,348,676	Vt.	8,594	196,815

BARLEY ACREAGE AND PRODUCTION—Continued

STATE	ACRES	BUSHELS
Wyo.	7,970	115,624
Tenn.	5,894	96,173
Ky.	5,612	119,542
Nev.	5,599	148,216
Me.	4,358	104,912
Md.	3,888	111,221
W. Va.	1,359	24,816
N. J.	894	14,613
N. H.	887	22,036
Ala.	577	5,312
Mass.	509	11,832
N. C.	429	3,510
La.	389	6,079
Conn.	274	4,892
Ark.	273	2,900
R. I.	145	3,154
Fla.	137	920
Del.	85	625
Ga.	21	65
U. S.	6,472,888	122,024,773

FIGURE 217.—Barley is produced principally in the Great Valley. It is used locally for feed and also exported through San Francisco to England for malting. In the Salinas Valley the acreage also is large, relative to arable area. Most of the crop is unirrigated. It is planted in October and November, after the first rain, and harvested in April or May. There are usually about 1,000,000 acres of barley harvested for grain in the region and the production is about 30,000,000 bushels. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

during these five years was far greater than in any preceding ten years.

Dairying, sheep, and poultry production are the animal enterprises that have increased notably in California since the World War, whereas not only have the number of beef cattle and hogs decreased, but also the number of horses and mules has declined notably. However, there has been a marked recovery in the number of hogs during the past two years. The trends in these livestock enterprises are of interest in view of the need of finding alternative enterprises to the production of fruits and vegetables, for which it is becoming increasingly difficult to obtain markets. It may be added that the only animal products which are shipped out of the state to a material extent are wool, lamb, and eggs.

Increase in Fruits and Vegetables

While the acreage in grain and hay crops has decreased and the production of meat has increased only slightly, both the acreage and production of the fruits and vegetables have increased notably. The census figures on the number of fruit trees are comparable only as far back as 1909, when all the fruit orchards and vineyards occupied about 800,000 acres. Ten years later, in 1919, the area had increased to about 1,000,000 acres, or 25 per cent. Five years later, in 1924, the fruit area had increased to about 1,400,000 acres, or 40 per cent. Whereas from 1909 to 1919 the increase in fruit acreage was about 2.5 per cent a year, or a half more rapid than the increase in the nation's population, from 1919 to

1924 the rate of increase was about 8 per cent a year, or five times as rapid as the increase in the nation's population. By 1928 the estimates of the State Statistician indicated that the fruit area had increased to about 1,700,000 acres—a gain almost as rapid as in the five years preceding.

The increase in production prior to the war was about the same as the increase in acreage, but since the war it has been smaller. Combining the production of the nine most important fruits and nuts on the basis of the average farm price during the decade 1917–1926, it appears that the aggregate increase in production was about 24 per cent between the five-year period 1907–1911 (centered on the census year 1909), and the five-year period 1917–1921. But, between the period 1917–1921 and the period 1922–1926, production increased about 28 per cent. This smaller increase since the war in production than in acreage is probably owing principally to a larger number of young trees and vines in recent years than previously, and it may be owing in part to planting trees and vines on poorer soil.

The increase in acreage and production of vegetables grown for sale has been even more rapid. From 1899 to 1919 the increase in area, according to the Census, was from 28,000 to 146,000 acres, or five-fold in the twenty years. From 1919 to 1924, the area increased from 146,000 to about 234,000 acres, or 60 per cent. Even in this latter period the rate of increase in acreage of vegetables was about as large as that in the fruits, or seven times as great as the increase in the nation's population. In 1929 the area in vegetables was 401,000 acres, according to the estimates of the State Statistician, an increase of over 70 per cent in the five years.

Agriculture and Land Values

The total agricultural production of California at the present time is about three times that at the beginning of the century, when the acreage of harvested crops was greater than now. In other words, production per acre has increased three-fold. This has been accomplished principally (1) by shifts from less productive to more productive crops per acre, notably from grain crops to fruits and vegetables, and from grain hay toward alfalfa, and (2) by shifts from less productive to the more productive classes of farm animals per unit of feed consumed, notably from beef cattle to dairy cattle and poultry.

As a consequence of these shifts from the less productive to the more productive crops and farm animals, there has occurred an enormous increase in the value of land per acre. Wheat land is worth today perhaps $50 per acre, orchards $500 or more; grazing land for beef cattle is worth, perhaps, $25 an acre or less, hay land for dairy cows $100 an acre or more. California cannot go back to the more extensive systems of farming without experiencing a devastating decline in land values. A great decline in land values would mean an increasing rate of taxation, a tightening of credit, doubtless the failure of banks and business depression.

Nearly one-third of the crop land of California, a higher proportion than in any other state, is devoted to fruits and vegetables. These are the most intensive of all crop enterprises, and if California is to avoid serious economic consequences it cannot decrease this acreage very much. The solution of California's agricultural problems apparently must be found elsewhere, and, apparently is being found in the development of improved varieties of fruits and vegetables, the introduction of new crops, such as cotton in the San Joaquin Valley, by finding larger markets both at home and abroad, and in other ways.

CHANGES IN THE EFFICIENCY OF LABOR

Decreasing the cost of production is a remedy commonly recommended as a partial solution of the agricultural problem in California, as well as in other sections of the United States. One of the largest costs in agricultural production is the labor cost. In the United States comparison of the aggregate agricultural production (excluding crops fed to livestock) during the five-year period 1917–1921 with that in the period 1922–1926 indicates an increase of about 14 per cent. The months of hired labor employed in agriculture (expenditure for labor divided by average monthly wage, by states) decreased 2 per cent between 1919 and 1924, while farm population decreased 6 per cent. Taking 4 per cent as the approximate decrease in months of hired labor, and recalling that the number of farmers remained practically stationary, there is indicated a decrease in total labor applied to agriculture of about 2 per cent; and, consequently, an increase in production per month of labor employed of about 16 per cent.

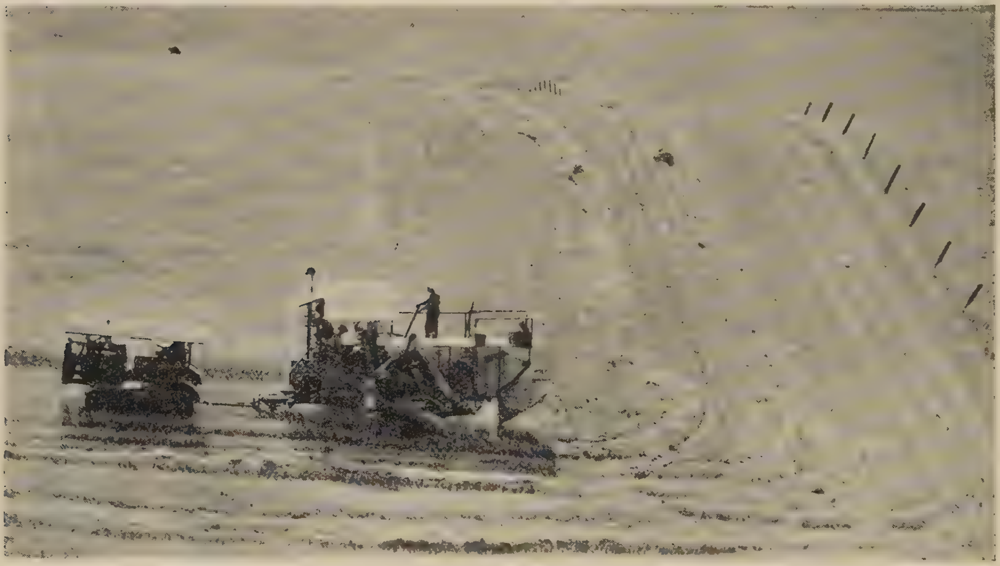


FIGURE 218.—In the earlier days the valleys of California, especially the Great Valley, were largely devoted to "bonanza" grain farming, and even yet many large farms remain. The picture shows a caterpillar tractor and combine-harvester cutting and threshing oats on one of the large farms. In the earlier days combine-harvesters were used, but were drawn by a steam engine, or sometimes by as many as 50 horses. (Photo from Los Angeles Chamber of Commerce.)

In California, preliminary estimates of agricultural production in the two periods 1917–1921 and 1922–1926 (each centered on the census year), which are deficient because of failure to include meat produced, and also because figures for milk and poultry products are available only for the census years, but which are, nevertheless, probably roughly comparable, indicate an increase of about 25 per cent in production between these periods five years apart. Between the central years of these periods the number of farms, or farmers, increased 16 per cent and expenditure for labor divided by average wage increased 25 per cent. It appears that agricultural production in California per unit of labor applied increased somewhat between these two census years, probably about 5 per cent. Between 1909 and 1919, agricultural production in California per unit of labor employed increased much more, probably about 30 per cent. More complete calculation may alter these figures, but it seems unlikely that they could alter the general conclusion that owing to development of new orchards and vineyards, and doubtless to many other factors also, including the drought in 1923–1924, agricultural production per unit of labor applied has not increased since the war as rapidly as in the decade before the war. The contrast of the estimated 5 per cent estimated increase in California for the five-year period with the 16 per cent increase for the United States as a whole is striking.

While the figures indicate a smaller increase in agricultural production per unit of labor since the World War than in the previous decade, the increase in production per farm has been at about the same rate as in the years prior to the war. This average production per farm increased about 13 per cent between 1899 and 1909, and 17 per cent between 1909 and 1919, while the increase between the period 1917–1921 and the period 1922–1926 was about 9 per cent.[7] This is nearly 2 per cent a year, or at fully as rapid rate as in the preceding decades. Viewing the quarter century as a whole, it is interesting to note that agricultural production per farm increased over 40 per cent, despite a decrease in area of crops harvested per farm from 96 acres in 1899 to 42 acres in 1924 (49 acres if crop failure be included).

The increase in agricultural production per unit of labor applied since the World War probably would have been smaller than it has been had not the tractor been rapidly introduced. On January 1, 1920, there were 12,131 tractors on California farms, and on January 1, 1925, there were nearly 30,000.[8] This was a more rapid increase than in the United States as a whole; and the ratio of tractors to work horses and mules was higher in 1925 in California than in any other State—one tractor to fewer than 12 horses. In the Corn Belt States there was only one tractor to 25 horses in Illinois; 31 horses in Iowa; and 77 horses in Missouri. Measuring the importance of the tractor by the percentage of farms that have tractors, California also ranks near the top. On January 1, 1925, one farm in five in California had a tractor. Only the Dakotas exceeded California in this proportion of farms having tractors. This is the more surprising in view of the fact that the average area of crops harvested per farm in 1924 was 262 acres in North Dakota, 198 acres in South Dakota, and only 42 acres in California.

The percentage of the farmers in

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[7] Sufficient data are not available to permit compilation of production by five-year periods prior to 1917.

[8] Although no data are available since 1925, rough estimates indicate that there are about 50,000 tractors on farms in California today (1929).

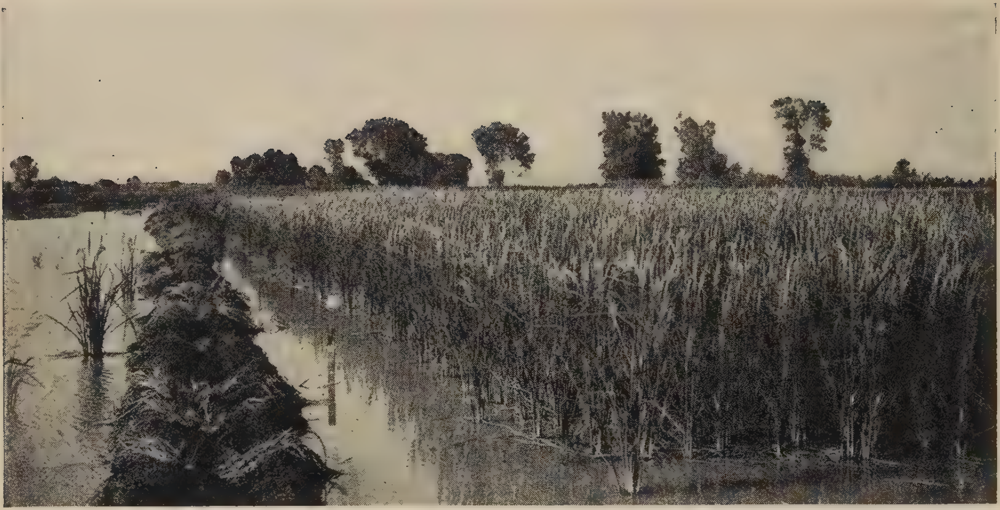

FIGURE 219.—Rice is a relatively new crop in California, extensive production dating from about 1909. It is grown almost wholly in the Sacramento Valley, where the rainfall is heavier and water from the mountains more abundant. After seeding on moist and carefully prepared ground, water is added as the plant grows until the field is covered about six inches deep. This depth is maintained until near harvest time, when the water is drained off, the ground allowed to dry and become sufficiently solid to carry a tractor and combine. (Picture taken near Biggs, in the Sacramento Valley, by C. E. Chambliss, U. S. Bur. of Plant Industry.)

California having automobiles is much greater. In 1920, the latest year for which data are available, 53 per cent had automobiles, a percentage that was exceeded only in the Western Corn Belt States and the Dakotas.

As a consequence of this widespread use of the tractor and automobile, a notable decrease has occurred in the number of horses and mules, as already noted. Between January 1, 1920, and 1928, the number decreased from 455,000 to about 343,000, or 25 per cent. If it required three acres of crop land in California to feed a horse, this would indicate the release of fully 300,000 acres of crop land for other uses, or to lie idle. Doubtless pasture land was released also. This release of farm land for other purposes is likely to continue for several years at least, as there are not enough colts on farms, either in the United States or in California, to replace half the horses that die or become unfit for use each year.

FIELD CROPS

The area of land in the Pacific Subtropical Crops Region from which crops were harvested in 1924 was about 5,400,000 acres. In addition there was nearly 900,000 acres of crop failure, as already noted.[9] Hay constituted about one-fourth of the crop acreage harvested, and the small grains over a fifth. Adding the acreage of corn and the sorghums brings the acreage in hay and grain to over one-half that of all crops. But, the value of these crops was not over one-fifth that of all the crops.

Alfalfa is the principal hay crop, constituting in 1924 over 40 per cent of the acreage in hay, but nearly 80 per cent of the production (Fig. 215).

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[9] The acreage of crops harvested in all California in 1929 is estimated at about 6,830,000 acres, of which 4,730,000 acres are field crops, 1,700,000 acres are fruit crops and 400,000 acres are vegetable crops.

The acreage of small grains cut green for hay, which grow during the winter and need not survive the summer drought, was greater in 1924 than alfalfa; but the acre-yield was only one-fourth as great (Fig. 216). This grain hay is cut only once, whereas alfalfa is cut from three to six times yearly. In recent years the acreage of grain hay has been declining.[10] In many places, especially in low, moist lands, the native wild grasses are also cut for hay. The value of the tame hay crop of California averages about $75,000,000, and the wild hay crop about $1,500,000.

Barley is the principal grain crop, averaging about a million acres during recent years (Fig. 217). It is hardier and more drought resistant than wheat, and is much better adapted to the climate than corn, which needs a summer rather than a winter rainfall. Over half of the grain grown in the region is barley. The production is heaviest in the Sacramento and northern portion of the San Joaquin valleys, where the rainfall is more adequate than farther south. Only 13 per cent was grown under irrigation in 1919, according to the Census.[11] It is used locally for feed, and is also exported through San Francisco to Europe for malting. Sometimes it absorbs enough moisture en route to pay the freight. The barley crop of California ranges from $20,000,000 to $25,000,000 in value.

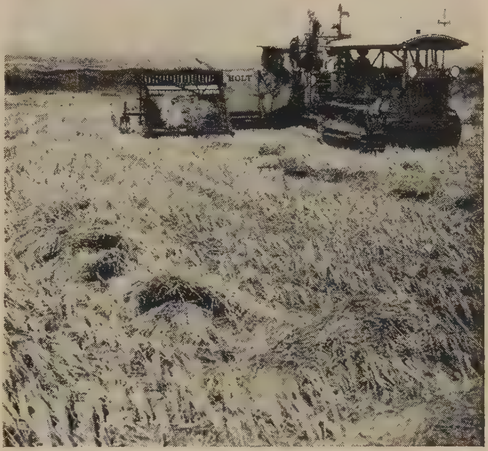

FIGURE 220.—The seeding and harvesting of rice in California is carried on in the same way as that of wheat and barley. The picture shows a tractor and combine-harvester picking up and threshing rice that has been cut and left in windrows. By using modern machinery California farmers are able to grow rice at so low a cost as to permit shipment across the Pacific Ocean and sale in Shanghai at a price often lower than the Chinese can afford to deliver it, despite the fact that the American farm laborer is paid a wage probably ten times that of the Chinese laborer. (Photograph from California Development Assn.)

Wheat was formerly a very important crop in the region, but now occupies an acreage and has a value only about three-fourths that of barley. The decline in wheat production, which was rapid between 1899 and 1909, was owing in part to the use of the better lands for more intensive crops, in part to the depletion of soil fertility after 40 years of continuous cropping. As a Californian of long experience once remarked to the writer, "It was wheat, then barley, then rye, then good-bye." War-time prices caused a recovery in 1919 to half the acreage two decades earlier, and although the acreage is now only two-thirds the 1919 level, it is much greater than in 1909. Wheat is grown principally in the same districts as barley. Only 16 per cent of the acreage was irrigated in 1919. California wheat is soft, and is either used locally for

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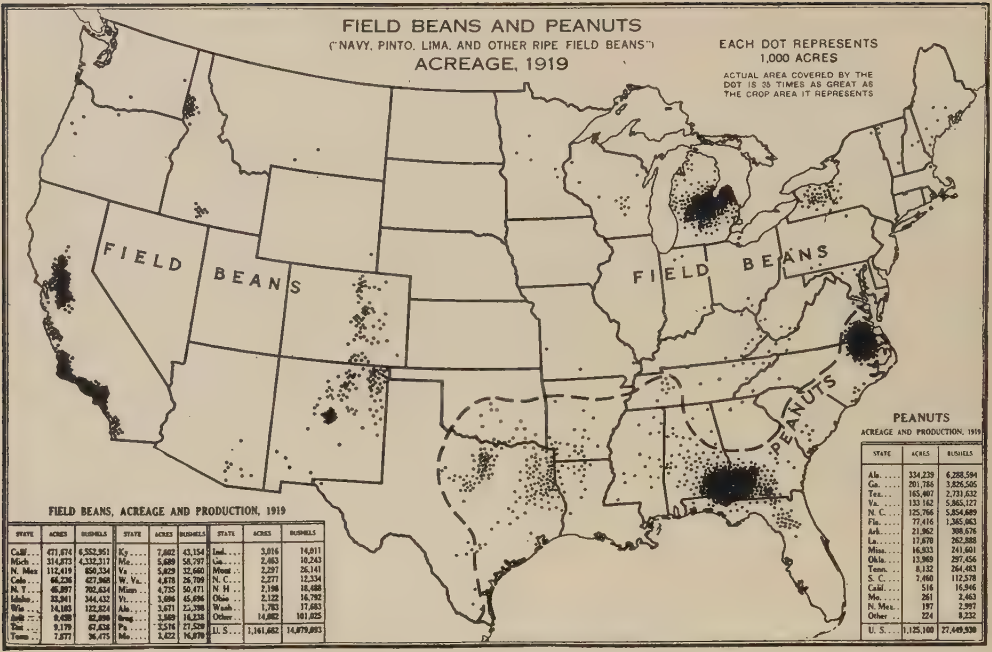
[10] In 1928 the area in alfalfa was estimated at 1,011,000 acres, in grain hay at 546,000 acres, in wild hay at 150,000 acres, and the total hay acreage as 1,804,000 acres.

[11] The Census Bureau asked each enumerator to mark on the schedule the crop grown on irrigated land, but undoubtedly many times the enumerator forgot to do so, hence this and both preceding and subsequent figures giving proportion of the acreage irrigated are probably too small.


FIELD BEANS AND PEANUTS
("NAVY, PINTO, LIMA, AND OTHER RIPE FIELD BEANS")
ACREAGE, 1919
EACH DOT REPRESENTS 1,000 ACRES
ACTUAL AREA COVERED BY THE DOT IS 35 TIMES AS GREAT AS THE CROP AREA IT REPRESENTS
FIELD BEANS
FIELD BEANS
PEANUTS

FIELD BEANS, ACREAGE AND PRODUCTION, 1919

STATE	ACRES	BUSHELS	STATE	ACRES	BUSHELS	STATE	ACRES	BUSHELS
Calif.	471,674	6,552,951	Ky.	7,602	43,154	Ind.	3,016	14,011
Mich.	314,873	4,332,317	Me.	5,689	58,797	Ga.	2,463	10,243
N. Mex.	112,419	850,334	Va.	5,829	32,660	Mont.	2,297	26,141
Colo.	66,236	427,968	W. Va.	4,878	26,709	N. C.	2,277	12,334
N. Y.	46,897	702,634	Minn.	4,735	50,471	N. H.	2,198	18,488
Idaho	33,941	344,432	Vt.	3,696	45,696	Ohio	2,122	16,792
Wis.	14,183	122,824	Ala.	3,671	25,398	Wash.	1,783	17,683
[illegible]	9,638	[illegible]	Oreg.	3,569	16,238	Other	14,882	101,025
Tex.	9,179	67,638	Pa.	3,516	27,529	U. S.	1,161,682	14,879,893
Tenn.	7,877	36,475	Mo.	3,422	16,870			

PEANUTS
ACREAGE AND PRODUCTION, 1919

STATE	ACRES	BUSHELS
Ala.	334,239	6,288,594
Ga.	201,786	3,826,505
Tex.	165,407	2,731,632
Va.	133 162	5,865,127
N. C.	125,766	5,854,689
Fla.	77,416	1,365,063
Ark.	21,962	308,676
La.	17,670	262,888
Miss.	16,933	241,601
Okla.	13,969	297,456
Tenn.	8,132	264,483
S. C.	7,460	112,578
Calif.	516	16,946
Mo.	261	2,463
N. Mex.	197	2,997
Other	224	8,232
U. S.	1,125,100	27,449,930

FIGURE 221.—California produces more dry beans than any other State, except Michigan. In Southern California nearly all the lima beans of the United States are grown, while in the coastal valleys to the north and in the Great Valley about half of the nation's crop of white beans was formerly raised. Now, however, the production of white beans in California is small compared with Michigan. California beans are shipped mostly to the Eastern States where the limas are used directly by the housewife, while many of the white beans are canned with pork and tomato juice, notably in Boston and Portland, Maine, and become the famous Boston baked beans of commerce. The lima beans are grown without irrigation in the fog belt near the coast, but most of the beans in the Great Valley are irrigated. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

flour or shipped to Europe and the Orient. The value of the wheat crop of California ranges, usually, from $15,000,000 to $20,000,000 in value.

Rice ranks third among the grain crops of the state. Its production is confined practically to the Sacramento Valley, where water for irrigation is more abundant than farther south. The area harvested has averaged about 150,000 acres in recent years, and production about 8,000,000 bushels, which is one-fifth of the nation's crop. A large proportion of the crop, especially when the price is low, is shipped to Japan and China. The use of modern machinery in seeding and harvesting enables the California rice grower to pay four dollars a day or more for farm labor and ship rice across the Pacific Ocean to countries where farm labor receives 40 cents a day or less (Figs. 219 and 220). The value of the crop averages about $10,000,000.

Although the acreage of oats is usually as large as that of rice, the value of the crop is scarcely a third as great. The oats are also grown principally in the Sacramento Valley, and are used locally for feed, mostly for horses. A little corn is grown in the region, 80,000 acres on the average, producing 2,500,000 bushels, or equivalent, which is about that of an average county in the Corn Belt. The corn is found mostly in the central part of the Great Valley and in Southern California. About a fifth of the crop is cut for silage and

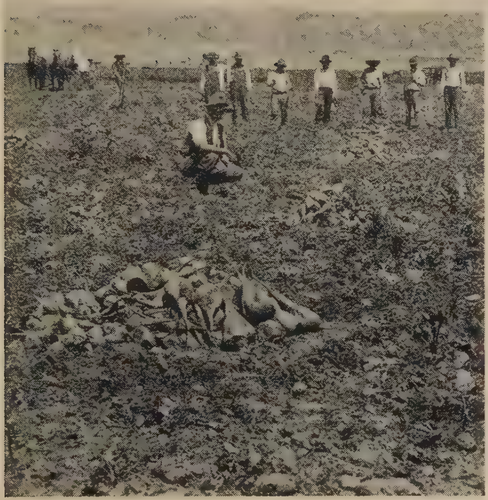


Figure 222.—Sugar beets are grown in the same districts as beans, and compete for the land with beans in some years. Sugar beets require a large amount of labor in plowing the land deeply, in planting, in thinning the plants in the row, then in cultivating and, finally, in harvesting, which is done largely by hand. In the picture, taken in Southern California, the beets have been lifted, the tops cut off and the topped beets placed in piles. It will be noted that there are ten laborers and the foreman working in the field. The beets will be thrown into wagons and hauled to the sugar factory promptly before their quality is lowered by fermentation. (Photo from Los Angeles Chamber of Commerce.)

practically all the grain also is used locally for feed. The acreage of the grain sorghums is now much greater than that of corn, and the yield per acre is about the same. The value per bushel, however, is less. These sorghums, which are grown mostly in the hot San Joaquin Valley, are better adapted to the dry summers than corn, which has the vitality of its pollen impaired by very dry air. However, the sorghums, like corn, are better adapted to a summer rainfall than to a winter rainfall type of climate. As both crops are grown during the summer, to secure the necessary heat, they are largely irrigated, 50 per cent of the corn and 75 per cent of the sorghums being irrigated in 1919, according to the census.

Figure 223.—This is one of the largest sugar factories in Southern California. The beets are dumped from the farmers' wagons or railroad freight cars into large, long bins, whence they are conveyed by a stream of water in a gutter to tanks for washing, after which they are sliced, heated in water to extract the sugar, and the juice treated by a number of processes. A sugar factory usually operates two to three months and then remains more or less idle for nine months. Most of the California sugar is used in the Western States, and its principal competitor is cane sugar from Hawaii. At present only 50,000 to 60,000 acres of beets are being grown in California, and the usual yield per acre of 8 to 10 tons of beets, produces one to one and a half tons of sugar. (Photo from Los Angeles Chamber of Commerce.)

Three other crops, beside fruit and vegetables, are of great importance in several localities in the region,—dry beans, sugar beets, and cotton. The beans and the beets are grown largely in the same localities, and both were somewhat more important a decade ago than they are now. The beans are grown along the southern coast (Santa Barbara, Ventura, Los Angeles, Orange, and San Diego Counties), in the Salinas Valley, and in the central part of the Great Valley (Fig. 221). Nearly the entire lima bean crop of the nation is grown in Southern California, mostly in the fog zone within ten miles of the coast, and where the average annual rainfall is only 10 to 15 inches. The lima beans are grown without irrigation, the fog apparently augmenting the rainfall and also reducing loss by shattering while harvesting, which is done by machinery. Pink, blackeye, small white, red Mexican and cranberry are also important varieties of beans, but these are grown mostly in the Salinas Valley or the Great Valley, where a large proportion of the crop is irrigated. The bean crop ranges from $13,000,000 to $25,000,000 in value.

The largest acreage of sugar beets is also along the southern coast, but the acreage in the lower Sacramento Valley is almost as large, while the Salinas and Santa Maria Valleys are also important centers of production (Fig. 222). In each of these areas there are one or more sugar factories (Fig. 223). The sugar beet crop of California now averages only about $4,000,000 in value.

Cotton is grown only in the interior valleys, mostly in the San Joaquin Valley and in the Imperial and Palo Verde valleys. The latter two valleys are located outside the Pacific Subtropical Crops Region. The production of cotton in the upper San Joaquin Valley has increased very rapidly in recent years, and cotton bids fair to become a very important crop in this valley. In 1924 the area in cotton in this valley exceeded 40,000 acres, and it is probably over twice as large today. The yield is from a half bale to a bale to the acre. Practically all the cotton is irrigated, and most of it is shipped to Japan, England, and Germany or to mills in Oakland and Los Angeles. The farm value of the cotton crop of California, including seed, was over $20,000,000 in 1929.

(Note.—*The rest of the instalment on the Pacific Subtropical Crops Region will be continued in the next issue.*)

LAND VALUES IN THE BLUE GRASS AND NASHVILLE BASINS

Raymond E. Murphy
Geographer, University of Wisconsin

"THE upland quality of the general regional slope of the Appalachian Plateaus is interrupted in Kentucky and Tennessee by lowlands of unusual size and importance. The Kentucky lowland is the Blue Grass country, famous for its rich limestone soils and its nutritious blue grass; the Nashville lowland or Central Basin is of equal importance, though it has for some reason never gained such general renown"[1] (Fig. 1).

The implied assumption that these two regions should be equally renowned is based on certain well-known facts regarding them. Both regions are topographic basins. Both basins were developed by the erosion of structural domes. Both are underlain chiefly by rocks of Ordovician age and are surrounded by rims of Mississippian rock. Both have residual soils resulting largely from the decomposition of Ordovician limestones. The soils of both regions have the reputation of being quite fertile and capable of supporting rich growths of blue grass. The fact that the two regions are near together and are both in the Interior Low Plateau Province makes any considerable climatic difference seem improbable.

How then can one explain the statement that the Nashville Basin "has for some reason never gained such general renown" as the Blue Grass Basin? There is no doubt that the latter has been mentioned much more frequently in the literature and is much oftener pointed out as an agricultural district *par excellence.*

This difference in the reputation of the two districts is borne out by a comparison of the land values based on the 1925 Census of Agriculture (Fig. 2). Thus, only one of the Nashville Basin counties has a land value greater than $50 per acre (Davidson County, in which Nashville is located, $74 per acre) while over half (19 out of 34) of the Blue Grass Basin counties have a land value exceeding $50 per acre, two counties have a land value per acre of between $100 and $150, and one, Fayette, $154. (For identification of the various counties, see Fig. 3.)

PHYSIOGRAPHY AND TOPOGRAPHY

That portion of the Cincinnati Arch lying south of the city of Cincinnati, Ohio, is divided into two structural domes. These two subdomes of the Arch originally extended above the general level of the surrounding country. In the baseleveling which ensued the cap rock of the domes was either entirely removed or greatly thinned. Softer rock underlay the cap rock so that with further uplift erosion progressed more quickly on the sites of the domes than elsewhere. Lowlands or

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[1] Isaiah Bowman: "Forest Physiography". John Wiley and Sons, New York, 1911, p. 700.

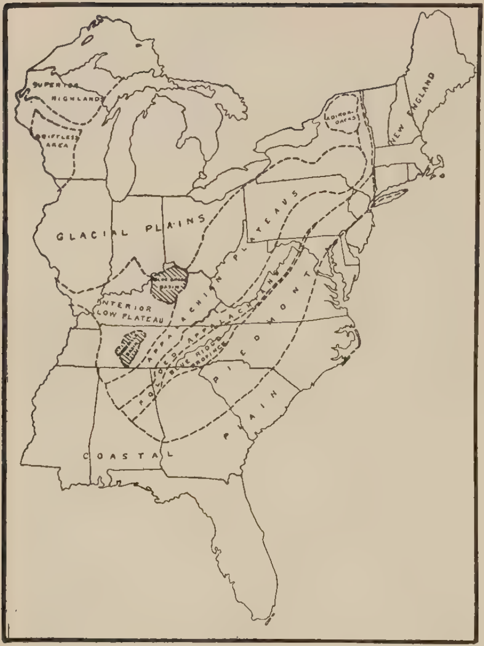

FIGURE 1.—Eastern half of the United States, showing location of Blue Grass and Nashville Basins and their relation to the various physiographic provinces. (Adapted from various sources.)

basins resulted, surrounded by uplands underlain by the hard strata such as once formed the cap rock of the domes. These two lowlands are known as the Blue Grass and Nashville Basins.

The two basins are alike topographically in that they consist dominantly of gently rolling country (Figs. 4, 5, and 6). Considered in more detail, differences become apparent.

Although there are local variations due to the character of the underlying rocks, the Blue Grass Basin is, in the main, a large area of gently rolling country with a narrow belt of knobs or hills surrounding it (Fig. 7). Some of these knobs are capped by Mississippian rocks while others owe their origin to the former presence of such a capping layer. Outside of this knobby belt is the true rim of the basin. The gently rolling topography of the central region is interrupted by several streams with deep and narrow valleys.

The extent of the gently rolling topography is considerably less in the Nashville Basin. Such topography is found there in many places, as in much of Rutherford County, but knobs, confined to the edge of the Blue Grass Basin, are not as limited in the Nashville Basin (Figs. 5 and 8). Knobs are found, for example, in southwestern Rutherford County, over much of southern Marshall and Bedford Counties and over part of Maury and western Williamson Counties. All such knobs are not capped by Mississippian rocks. Although many of them are, others had a capping of resistant Mississippian rocks preserved until relatively recent times geologically when removal by erosion left a knob of Ordovician rocks. The streams of the Nashville Basin, such as Stones River and the Cumberland, do not have valleys that are nearly as deep and narrow as those of equivalent size in the Blue Grass. Thus, the Cumberland River on the Nashville Topographic Sheet has cut a little over 100 feet below the level of the surrounding basin floor. Stones River on the Murfreesboro Sheet has a valley showing a maximum depth beneath the level of the basin floor of 60 feet and that only in the northwest corner of the quadrangle. The Harrodsburg Sheet of Kentucky, where the Kentucky River runs more than 300 feet below the surrounding basin level, shows a marked contrast to the situation in Tennessee. Apparently, the two basins have undergone slightly different physiographic histories.

The Blue Grass Basin was evidently reduced to a plain cut in

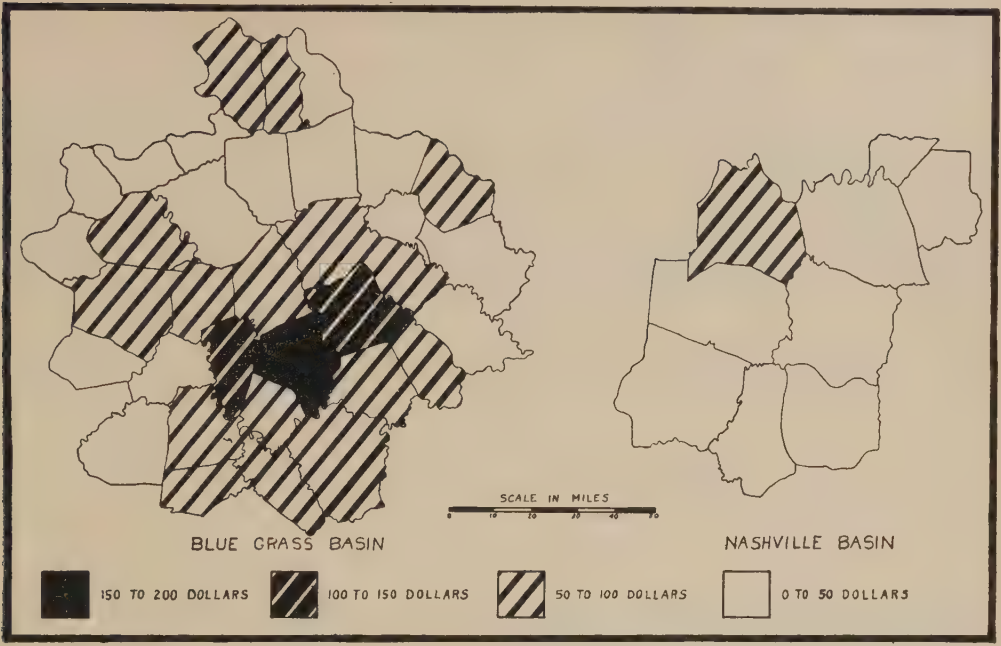

FIGURE 2.—Land values in the Blue Grass and Nashville Basins. The counties representing each basin were selected on the proportion of their area underlain by Ordovician rocks. A county having fifty per cent or more of its area underlain by Ordovician rocks was considered to be a basin county. (Based on U. S. Census of Agriculture, 1925.)

Ordovician rocks. That this plain was quite flat is shown by the absence of knobs over most of the Basin. On this low, level, land surface streams such as the ancient Kentucky meandered. A considerable uplift, possibly through further doming, gave the streams renewed vigor resulting in the entrenched valleys of today. The Basin floor is now in topographic youth with several streams flowing in deep narrow valleys across it.

The Nashville Basin was also reduced almost to a plain, but this plain was far from being as smooth as that of the Blue Grass Basin. The erosion cycle had not advanced as far as in the case of the Blue Grass Basin. Many knobs still projected above the fairly level floor of the Nashville Basin. When rejuvenation interrupted this cycle the uplift was not as great as that affecting the Blue Grass Basin, so that the streams have not had the incentive to cut as deep valleys.

The presence of scattered knobs or patches of knobs projecting above the general level of the Nashville Basin has very likely had some influence in determining the lower land values there. The Blue Grass Basin is probably more favored in the matter of topography since it lacks such scattered knobs, and the valleys which streams of the present erosion cycle have cut in its floor, though deep, are mostly quite narrow, leaving large uninterrupted areas of gently rolling to flat topography between them.

SIZE

The area of the Blue Grass Basin of Kentucky is about 8,000 square miles, while the area of the Nashville Basin is approximately 5,400 square

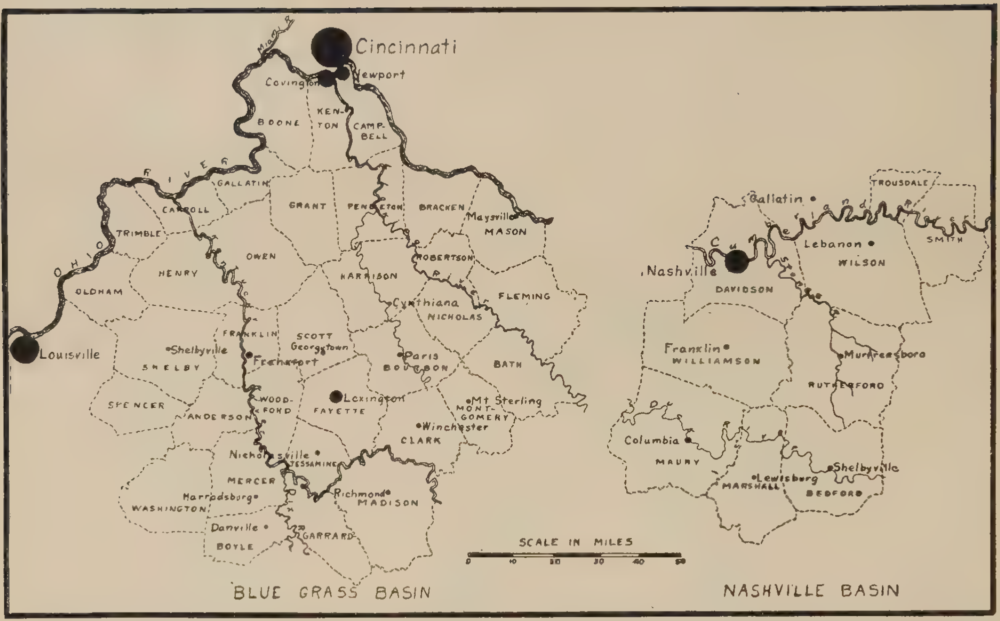
Miami R
Cincinnati
Covington
Newport
OHIO RIVER
BOONE
KEN-TON
CAMP-BELL
GALLATIN
CARROLL
TRIMBLE
GRANT
PENDLETON
BRACKEN
Maysville
MASON
OWEN
HENRY
OLDHAM
ROBERTSON
HARRISON
Cynthiana
NICHOLAS
FLEMING
Louisville
FRANKLIN
SCOTT
Georgetown
Shelbyville
SHELBY
Frankfort
Paris
BOURBON
BATH
SPENCER
ANDERSON
WOOD-FORD
Lexington
FAYETTE
Mt Sterling
MONT-GOMERY
Winchester
CLARK
Nicholasville
JESSAMINE
MERCER
Harrodsburg
WASHINGTON
Richmond
MADISON
Danville
BOYLE
GARRARD
SCALE IN MILES
0 10 20 30 40 50
BLUE GRASS BASIN
TROUSDALE
Gallatin
Cumberland River
Lebanon
WILSON
SMITH
Nashville
DAVIDSON
Franklin
WILLIAMSON
Murfreesboro
RUTHERFORD
Columbia
MAURY
Lewisburg
MARSHALL
Shelbyville
BEDFORD
NASHVILLE BASIN

FIGURE 3.—The Blue Grass and Nashville Basins, showing county names, principal rivers, and cities of 2,500 population or greater. The area of the circles is proportionate to the size of the cities. Population of cities based on 1920 Census.

miles. This latter figure includes considerable land in which knobs are plentiful, corresponding to the border regions of the Blue Grass Basin.

The greater size of the Blue Grass Basin would tend toward higher land values there than in the Nashville Basin. That valuable property

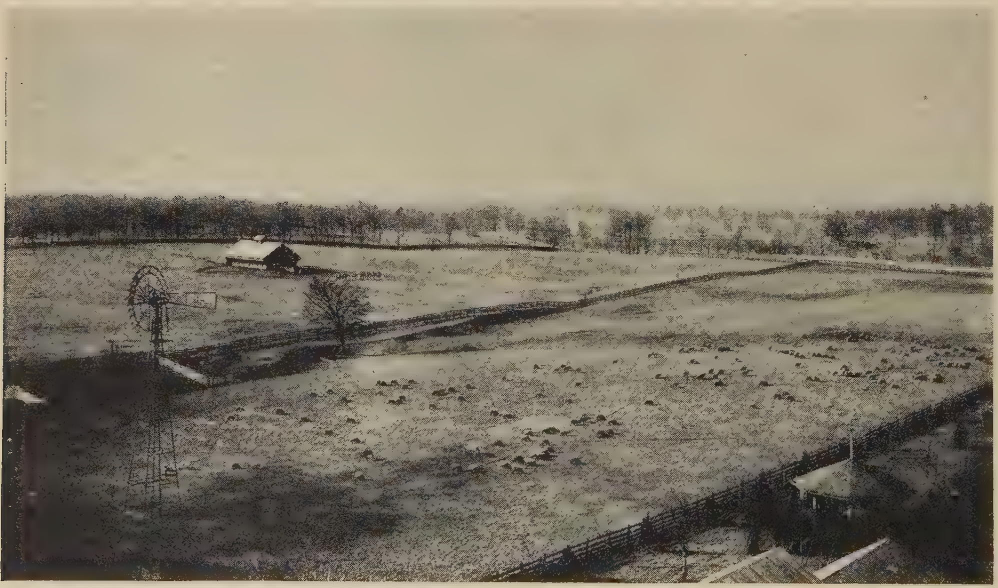

FIGURE 4.—Typical topography of the central part of the Blue Grass Basin. Two important activities of the region are represented in this view, the raising of sheep and the raising of thoroughbred horses. The farm is one of several large stock farms situated near Lexington in the Inner Blue Grass. (Photograph from R. L. McClure, Lexington, Ky.)

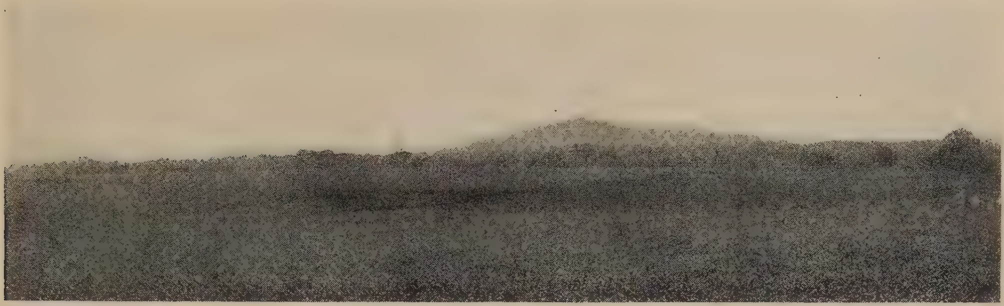

FIGURE 5.—Typical topography of the Nashville Basin; flat to gently rolling land in the foreground with an isolated hill or knob in the background. The presence of these knobs here and there in the Basin probably results in lower average land values than would otherwise be the case. About five miles southwest of Murfreesboro in Rutherford County, Tennessee. (Photograph from Agric. Experiment Station, Knoxville, Tenn.)

keeps up the value of adjacent property is a fact too well known to require elaboration.

SOIL

The soils of these two regions are proverbially rich, but, as pointed out earlier, that of the Blue Grass Basin enjoys a better reputation than that of the Tennessee area.

FIGURE 6.—Scene near Mt. Pleasant, about ten miles southwest of Columbia, in Maury County, Tennessee. The view was taken from one of the knobs of the region and shows in the background some of the gently rolling farm land that has given the Nashville Basin such a good reputation as an agricultural district. Phosphate is mined in this area. (Photograph from Walter F. Pond, State Geologist of Tennessee.)

The soils of both regions (though not of the knobs) were derived mostly from Ordovician rocks which were dominantly limestones. These soils were, originally at least, high in lime and had a fairly high phosphorus content.

Shaler refers to the soil of the two basins saying, after a discussion of the Blue Grass Basin: "The blue limestone soils are continued southward through Tennessee to the northern border of Alabama, but owing to the sandier nature of the rock in that section they produce somewhat less fertile soils than in the central portion of Kentucky."[2] Descriptions of the geologic character of the rock from which the soil was derived in these two regions do not seem to bear out Shaler's suggestion that the parent rocks of the Tennessee soil were sandier.

The Kentucky region has been subdivided into the Inner Blue Grass,

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[2] N. S. Shaler: "The United States of America." D. Appleton and Company, New York, Vol. 1, 1894, p. 106.

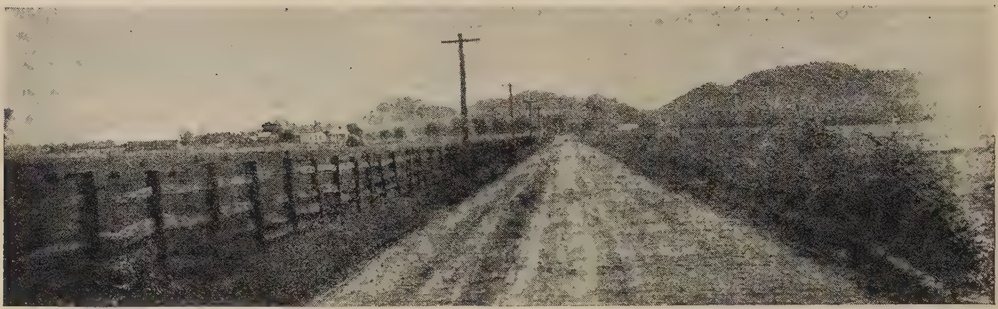

FIGURE 7.—Transition from Blue Grass Basin to Knobs. Scene about eight miles south of Danville, Kentucky. The belt of knobs surrounding the Blue Grass Basin is narrow. This is in marked contrast to the way in which knobs are scattered over the Nashville Basin. (Photograph by Prof. A. M. Miller.)

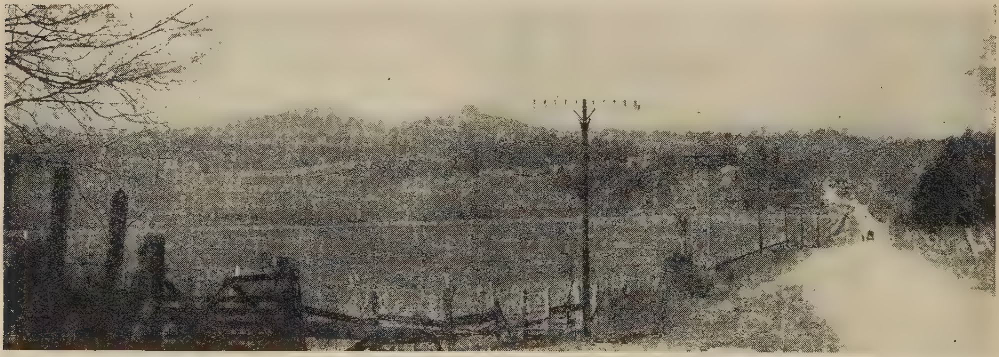

FIGURE 8.—Scene in the southeastern part of Davidson County, Tennessee. Hills, such as the ones shown in the background here, are probably partly responsible for the lower average land values in the Nashville Basin than in the Blue Grass Basin. (Photograph from Walter F. Pond, State Geologist of Tennessee.)

the Eden Shale Belt, and the Outer Blue Grass on the basis of the character of underlying rock and the manner in which it is reflected in topography and soil (Figs. 4, 9, and 10). The Nashville Basin has not been subdivided in this way so a comparison on this basis cannot be made. The oldest rocks exposed in the Nashville Basin are as old as, or older than, those of the Inner Blue Grass, and Mississippian rocks form the rims of both basins. The characters of the rocks of the various ages seem much the same in the two regions. The bed rock in both regions is high in phosphorus. In short, the information available does not indicate an explanation of the difference in land values in the two basins on the basis of difference in underlying rock formations and consequent difference in soil.

Soil surveys have been made of a few counties in each region. They seem to indicate quite similar soil types in the two basins, but detailed comparisons based on these soil surveys are impossible, due to the limited area that has been thus covered.

CLIMATE

Both of these regions enjoy a climate which is quite favorable for agriculture.

The mean annual precipitation is about 40 to 45 inches in the Blue Grass Basin, while that in the Nash-

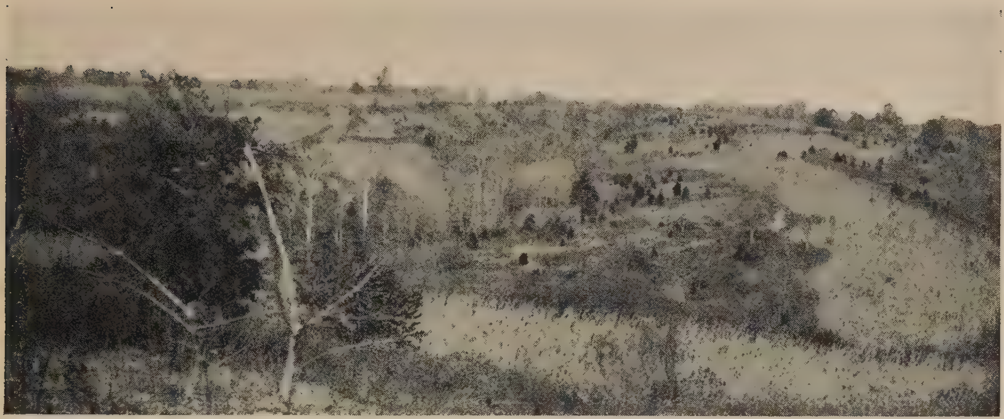

FIGURE 9.—Patchy cultivation of some of the more badly eroded land in the eastern part of Shelby County, Kentucky. This is in the Eden Shale Belt the soils of which are commonly of lower fertility than those of either the Inner or Outer Blue Grass between which it lies. (Photograph from the U. S. Dept. of Agric.)

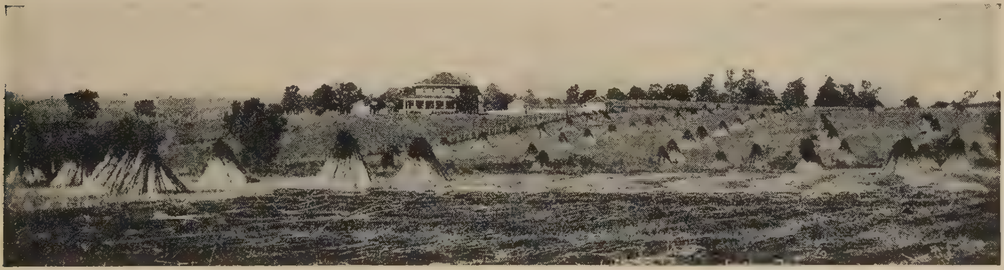

FIGURE 10.—View in the Outer Blue Grass near Shelbyville, Kentucky. The crop in shock is hemp, a crop which is no longer important in the Blue Grass Basin. Corn, hay, wheat, and tobacco are the principal crops of this vicinity. (Photograph from the U. S. Dept. of Agric.)

ville Basin is about 48 to 49 inches. Distribution throughout the year is about the same for the two regions.

Temperatures are in general somewhat higher in the Nashville Basin than in the Blue Grass Basin—a natural consequence of the difference in latitude. The length of the growing season averages about 180 days in the Blue Grass Basin compared to slightly over 200 days for the Nashville Basin.

The climate of the Nashville Basin seems if anything slightly the more favorable of the two for agriculture.

LOCATION

In the matter of location the Blue Grass Basin seems to be the more favored of the two districts (Figs. 1 and 3).

The Blue Grass Basin borders the Ohio River, a natural avenue of transportation, and is penetrated by a river navigable for small boats, the Kentucky. The Nashville Basin can only be reached by water by a long trip from the Ohio on the Cumberland River which is comparable to the Kentucky in navigability.

The Blue Grass Basin is favored in its proximity to large cities, the most notable examples being Cincinnati and Louisville, both located just outside the Blue Grass Basin. The development of both of these and particularly Cincinnati has been influenced by the presence of the fertile

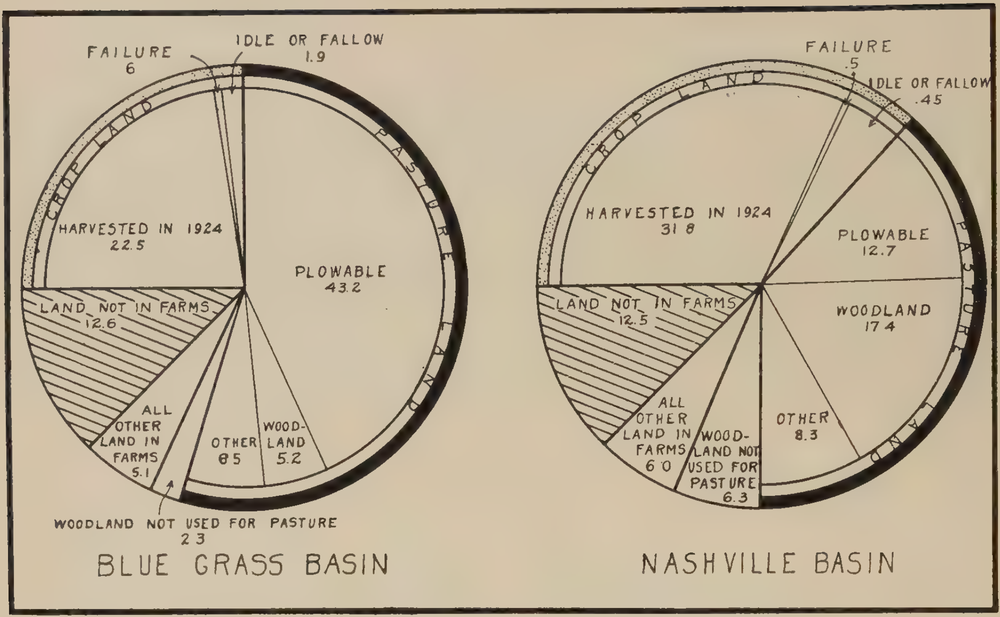

FIGURE 11.—Land utilization in the Blue Grass and Nashville Basins. Figures given are in each case per cents of total areas of the basins. (Based on figures from the U. S. Census of Agriculture, 1925.)

lowland though the influence of the Blue Grass Basin has probably not been the primary one in either case. What has been the effect of these cities? Undoubtedly land values in the Blue Grass Basin are on the whole somewhat higher than they would have been without these large cities nearby.

The main arteries of trade in the United States run east-west and lie to the north of the Ohio River. The Blue Grass Basin lies nearer to these main paths of trade than does the Nashville Basin.

The Blue Grass Basin merges at the north into the valuable farming lands of Indiana and Ohio. The Nashville Basin, on the other hand, is entirely surrounded by relatively poor land. These conditions favor higher land values in the Blue Grass Basin.

HISTORY

The first permanent settlers for both the Blue Grass Basin and the Nashville Basin came by way of the Great Valley. From there, part went northwest to the Blue Grass by way of the Wilderness Road, and part, slightly later, went across country to the southwest to Nashville.

The Blue Grass Basin was from the first favored in the matter of greater accessibility. When the earliest settlers came down the Great Valley, they found the journey into the Blue Grass Basin through Cumberland Gap shorter and easier than the trip overland to Nashville or the alternative trip down the Tennessee and up the Cumberland River.

Later when people and merchandise came down the Ohio River from Pittsburgh the Blue Grass Basin was again at an advantage. Michaux, who visited these two regions in 1802, wrote regarding Nashville: "The price of labour is higher in this town than at Lexington, and the same disproportion exists between this price and that of provisions. There ap-

FIGURE 12.—Scene of the birthplace of Man O'War, famous Kentucky race horse, about four miles north of Lexington, Kentucky. The raising of thoroughbred horses has been an important factor in the maintaining of high land values in this part of Kentucky. (Photograph from R. L. McClure, Lexington, Ky.)

peared to be from fifteen to twenty shops, which are supplied from Philadelphia and Baltimore, but they did not seem so well stocked as those at Lexington, and the articles, though dearer, are of an inferior quality. The cause of their being so dear may be in some measure attributed to the expense of carriage, which is much greater on account of the amazing distance the boats destined for Tennessee have to go up the Ohio. In fact, after having passed by Limestone, the place where they unload for Kentucky, and which is four hundred and twenty miles from Pittsburgh, they have still to make a passage up the river of six hundred and nineteen miles to reach the mouth of the river Cumberland, and a hundred and eighty miles to arrive at Nashville, which, in the whole, comprises a space of one thousand five hundred and twenty-one miles from Philadelphia, of which twelve hundred are by water."[3] Michaux uses "up the river" where he evidently means down the river. The town of Limestone referred to is now known as Maysville and is located in Mason County.

In the shipping of produce down river to New Orleans the settlers of the Nashville Basin were probably at a slight advantage, and they certainly were favored on the return trip overland via the Natchez Trace.

Early in the history of the two basins greater accessibility, greater size, and possibly slightly smoother topography gave the Blue Grass Basin the reputation of being the more attractive of the two. As a natural consequence the Blue Grass Basin had several thousand settlers before the first permanent settlement in the Nashville Basin was established.

Other influences that might be classed as historical are the bringing of race horses into the Blue Grass and the establishment of the tobacco industry.

Race horses were brought into the Blue Grass Basin just after the Revolutionary War and the development of racing and the breeding of race horses has been an important factor in determining the high land values of the Inner Blue Grass.

The tobacco industry was started in the Blue Grass by the early settlers but did not assume great importance until after the appearance of White Burley in Brown County, Ohio, in 1864. This new type soon gained in general favor and displaced the dark tobaccos which were grown at that time in the Blue Grass. It is at present more valuable than the dark tobaccos of western Kentucky. The fact that this new type was discovered in an Ohio county adjacent to the Blue Grass doubtless is partly responsible for the widespread growing of the type in the Blue Grass Basin today. The tobacco industry, having started in the Blue Grass Basin, acquired a reputation in the district. Thus, as tobacco, particularly this White Burley became a valuable crop, land values rose.

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[3] F. A. Michaux in "Early Western Travels," edited by Reuben Gold Thwaites. Arthur H. Clark Company, Cleveland, 1904, pp. 251–252.

LAND UTILIZATION

The most outstanding features of land utilization in these two regions are the larger proportion of crop land in the Nashville Basin and of plowable pasture land in the Blue Grass (Fig. 11). The greater number of horses, sheep, and cattle raised in the Blue Grass is a reflection of this difference.

The development of horse racing and the breeding of thoroughbred horses in the Blue Grass (Fig. 12) deserves further mention. This industry has been referred to already as having gotten its start in the region just after the Revolutionary War. That the industry developed to a greater extent in the Blue Grass than in the Nashville Basin is probably due in considerable part to chance although the greater accessibility, greater size, and slightly smoother topography of the Blue Grass Basin were probably factors in the situation. That the industry should be largely concentrated in Fayette County rather than spread out over the Blue Grass is a consequence of the central location of Fayette County, the superior soil and hence superior pastures of the Inner Blue Grass as compared with other parts of the Basin, the presence of the city of Lexington, and various other influences. That the growing of thoroughbred horses has had an effect on land values is suggested by the fact that Fayette County, the principal seat of this industry in these two basins, has the highest average land values of any county in either basin. This influence is particularly important in Fayette County and through it the surrounding counties have been somewhat affected. As will be mentioned later the high

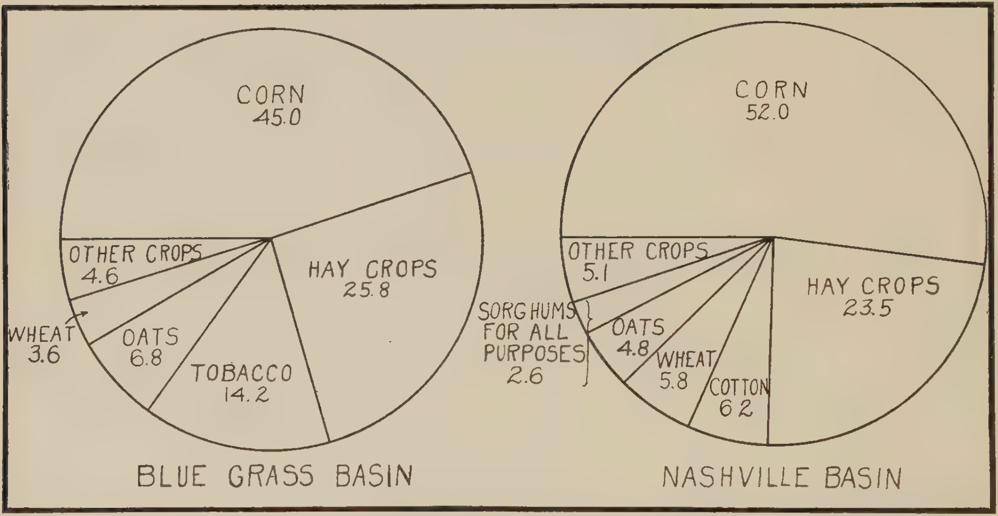

FIGURE 13.—Utilization of crop land harvested in 1924 in the Blue Grass and Nashville Basins. Figures given in each case are per cents of the total crop land harvested. (Based on figures from the U. S. Census of Agriculture, 1925.)

land values in the Blue Grass in general are probably due in considerable part to the tobacco industry but in Fayette County there is also the important influence of the thoroughbred horse industry. Still another factor enters into the matter of high land values in Fayette County and that is the presence of the city of Lexington.

Utilization of crop land differs in one or two important respects in the two basins (Fig. 13). A larger proportion of the crop land is devoted to corn in the Nashville Basin than in the Blue Grass Basin and very little tobacco is raised in the Nashville Basin (Fig. 14) while it makes up 14.2 per cent of the entire acreage cropped in the other (Fig. 15). Some cotton is grown in the Nashville area, while there is none grown at all in the Blue Grass.

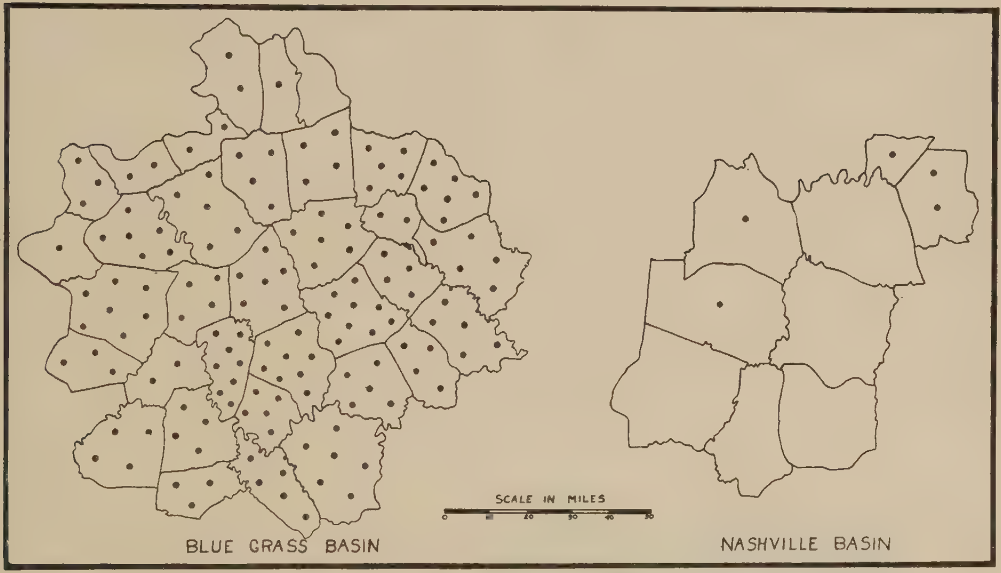

Figure 14.—Tobacco production in the Blue Grass and Nashville Basins for 1924. Each dot represents 1,000,000 pounds. (Based on figures from the U. S. Census of Agriculture, 1925.)

What, if any, relation exists between crops grown and land values? If one compares the map showing value of crops per acre (Fig. 16) with the tobacco production map (Fig. 14) and the map showing value of land per acre (Fig. 2) many similarities are seen. The Nashville Basin counties grow little tobacco and they have low crop values per acre and low land values per acre; the Blue Grass Basin counties, particularly those of the central Blue Grass, grow a great deal of tobacco and they have high crop values per acre and high land values per acre.

A partial explanation of this situation seems to lie in the nature of tobacco as a crop. It has a high value per acre, many times that of either corn or cotton. That being the case, tobacco land is of higher value than corn or cotton land notwithstanding the fact that after one or two crops of tobacco the land must be planted in blue grass and left in pasture for several years. The greater development of the tobacco industry in the Blue Grass may therefore furnish a partial explanation for the difference in the land values.

FIGURE 15.—A field of tobacco near Lexington, Kentucky. Some tobacco is grown especially for the seed. The pods, after the bloom has fallen, are covered with paper bags to protect them and insure perfect seed. The extensive raising of tobacco probably accounts in large part for the high value of crops per acre in this region. (Photograph from R. L. McClure, Lexington, Ky.)

If tobacco is such a valuable crop, why isn't it grown to a greater extent in the Nashville Basin instead of corn and cotton, which have considerably less value? As in the case of the thoroughbred horses there has probably been a large element of chance. Tobacco growing just got started earlier in the Blue Grass Basin and developed into an important industry. Also, it fitted in very well with the thoroughbred horse raising of the Inner Blue Grass and the more widespread raising of work horses, cattle, and sheep. Tobacco requires a fertile soil of high humus content and these conditions are best met by plowing up old sod. In order that this practice may be kept up and tobacco planted only on this newly broken ground the farmer must maintain a large acreage of pasture land compared to his tobacco acreage. Tobacco growing just did not happen to be started in the Nashville Basin until the growing of corn and cotton had been established there. It seems probable that the element of chance

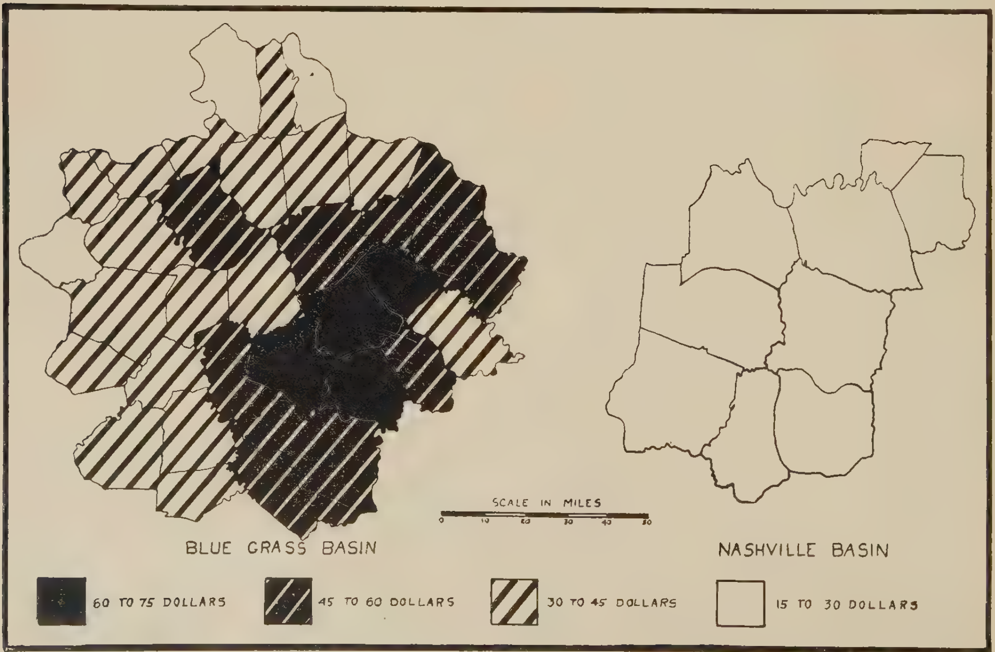

FIGURE 16.—Value of crops per acre of crop land for 1924 in the Blue Grass and Nashville Basins. (Based on U. S. Census of Agriculture, 1925.)

has been more important here than soil differences and that eventually the Burley tobacco of the Blue Grass may be grown extensively in the Nashville Basin.

SUMMARY

The 1925 Census of Agriculture shows land values in the Blue Grass Basin of Kentucky averaging considerably higher than those of the Nashville Basin of Tennessee although these two basins seem at first consideration to be identical in their natural equipment.

The Blue Grass Basin probably has a larger proportion of level land than the Nashville Basin. The Blue Grass Basin is larger and it is more favorably located. From the visits of the earliest settlers the Kentucky area has enjoyed the better reputation of the two, probably due to greater accessibility, greater size, and somewhat larger proportion of level land. The raising of thoroughbred horses is and has been much more important in the Blue Grass Basin, or, at least, in Fayette County, than in the Nashville Basin, and this has been partly responsible for the high land values of the central part of the Blue Grass. The tobacco industry also has become very important in the Blue Grass Basin, and, since tobacco is a valuable crop, high land values have resulted, with little tendency to speculation.

BOOK REVIEWS

DEPARTMENT OF COMMERCE

Bureau of Foreign and Domestic Commerce

The Market Data Handbook of the United States. By Paul W. Stewart. Price, $2.50.

Contributions of an outstanding character recently have been issued by the Bureau of Foreign and Domestic Commerce. *The Market Data Handbook of the United States* by Paul W. Stewart of the Domestic Commerce Division pioneers in a field where the business world urgently has needed reliable and concrete information; namely, the territorial extent and the economic composition of market areas. Three general types of markets are considered: the general consumer, the farm, and the industrial market. The county was selected as the physical unit, primarily because it is the smallest political unit for which satisfactory statistics are available.

Statistics on the general consumer market cover such facts as population, manufacturing, agriculture, mining, bank deposits, number of individual income tax returns, number of families with telephones, number of passenger automobiles, and number of trade outlets.

The farm market covers the number of farms, the farm population, land areas, value of crops, farm values, and others. For the figures on the industrial market, a special compilation was made by the Bureau of the Census using the 1927 Census of Manufactures. This gives the first figures by counties since the 1919 Census.

Extensive new data have been collected and presented for the first time, in addition to material from other government departments, and from many private sources.

Four maps accompany the volume, representing different phases of the market territory problem.

These valuable and well-organized statistical data afford an opportunity for the geographer in making a study of the geographic element inherent in many marketing problems.

Port Studies in Coöperation between the Bureau of Foreign and Domestic Commerce and U. S. Shipping Board.

The Transportation Division has, in coöperation with the United States Shipping Board, published two port studies, and a bulletin giving complete statistical data on foreign bunkering stations.

The port studies are based upon careful field work.

The Port of Hamburg. By Ralph I. Schneider of the United States Shipping Board. Foreign Port Series No. I. Price, $1.00.

This study presents in detail the description, port organization, physical facilities, cargo handling methods, equipment and labor, port charges, communication, port commerce, hinterland, rate conferences and railway rates, together with the economic and industrial phases of the free port of Hamburg. The maps in the pocket in the back cover illustrate many phases of the text, showing port facilities, the Warehouse City, principal railways in Germany, principal inland water systems in Germany, traffic for United States ports in Hamburg, and several others. The maps are clearly drawn, and well executed in blue, black, and white.

The book as a whole contains much material of value to the geographer, and the detailed statistical tables on commerce of the Port of Hamburg, and origin and destination of rail-borne commerce of the Elbe River port furnish opportunity for interesting geographical studies.

The Port of Liverpool Including Birkenhead and Garston. By Edward P. Cotter. Foreign Port Series No. 2. Price, $1.00.

This study contains the same material for Liverpool as that described above for the Port of Hamburg, including some excellent maps.

The field work of several months in each of these ports was supplemented by intensive study here at home, and the manuscript was in each case sent to the port officials abroad for a final and most meticulously careful check. Probably no book has been issued containing the amount of reliable and detailed material on either of these ports. It will be of immeasurable value to all geography students of trade problems. In fact each volume in itself is challenge for a geographer to make a careful geographic analysis, such as was not permitted to the authors in the instructions under which they worked.

Survey of Current Business, February, 1930. Semi-annual number. No. 102.

This survey is designed to present each month a picture of the business situation by setting forth the principal facts regarding the various lines of trade and industry. At semi-annual intervals, detailed tables are published giving for each item monthly figures for the past two years and yearly comparisons, where available, back to 1913.

Foreign Trade in Fresh Fruits. By Daniel J. Moriarty. Trade Promotion Series No. 90. Price, 25 cents.

The United States is ever increasing its production of fresh fruit. Doubling of the value of exports of fresh fruits between 1923 and 1927 has induced growers, exporters, and others engaged in this industry to take a greater interest in marketing their produce abroad. In 1928 the United States exported 56 million dollars' worth of fresh fruits.

Dried-Fruit Industry and Trade of South Africa. By Cecil M. P. Cross. Trade Information Bulletin No. 676. Price, 10 cents.

As one of the regions where the production of fruit is increasing, the Union of South Africa is of interest to dried-fruit producers and exporters in the United States. This bulletin outlines the history, present status, and prospects of the fruit industry in South Africa, and should prove of interest to American exporters of dried fruits.

Market for Sawmill and Woodworking Machinery in Mexico, Guatemala, Panama, Cuba, and Porto Rico. Trade Information Bulletin No. 675. Price, 10 cents.

This bulletin has been prepared to assist the American exporter of this type of machinery to determine the present and potential demand for his particular product and to devise the most effective methods for introducing new machinery and increasing the sales of lines already established. A good description is given of sawmill and woodworking activities and methods now being followed in each of the markets covered. It shows the types and sources of machinery now in use, contains practical information on the best ways to secure new business, and includes numerous other details.

The Margarine Industry of Europe. By E. L. Thomas. Trade Information Bulletin No. 677. Price, 10 cents.

This publication gives information on the margarine production, trade and consumption of various European countries, outlines the commercial practice followed, and sets forth the legislation which affects the industry.

Markets for Fuel-Oil Burners in the Eastern Hemisphere. Trade Information Bulletin No. 679. Price, 10 cents.

During recent years there has developed a foreign demand for American fuel-oil burners and parts, but the importance of that market is demonstrated by the fact that exports from the United States under this heading have increased approximately 48 per cent.

The Market of Foodstuffs in Guatemala. By Trade Commissioner H. P. Macgowan. Trade Information Bulletin No. 678. Price, 5 cents.

Foodstuffs of various kinds to the value of about 4 million dollars are imported annually into Guatemala, and it is estimated that about 90 per cent of the total is supplied by the United States. Some of the principal imports are flour, rice, wheat, canned fruit and vegetables, crackers and biscuits, packing-house products, dairy products, and dried fruit. There is only a small market for some of these products, but the demand for others is increasing.

U. S. COAST AND GEODETIC SURVEY

Distances Between United States Ports. Price, 10 cents.

This recently issued publication should prove of value to geography instructors and students and to those interested in the factors affecting distance, along a route marked by aids to navigation and affording a safe depth for the maximum draft that can enter both harbors. Distances can be obtained between practically any two ports of the United States, its territories, and its possessions. Tables are given which show distances between ports on the Atlantic, Gulf, and Pacific coasts; on the Atlantic coast inside routes; on the Hudson, Mississippi, and Ohio Rivers; on the Great Lakes; in the Virgin Islands, Porto Rico, Philippine, and Hawaiian Islands; and between the United States and a few foreign ports; together with tables showing time required to run various distances at different speeds.

The Bowie Method of Triangulation Adjustment. By Oscar S. Adams. Special Publication No. 159. Price, 10 cents.

This publication contains a discussion of the new method for the adjustment of a triangulation net as applied in the western part of the United States.

BUREAU OF FISHERIES

Fishery Industries of the United States, 1928. By R. H. Fiedler. Fisheries Document No. 1067. Price, 35 cents.

This report constitutes a yearbook on fishery statistics of the United States as well as a summary of activities of the division of fishery industries.

BUREAU OF MINES

Summarized Data of Lead Production. By Lewis A. Smith and others. Economic Paper 5. Price, 15 cents.

This paper deals with the production of lead since 1800 and is the fourth of a series of Bureau of Mines papers that, when completed, will cover the production of all the common metals.

Analyses of Maryland Coals. Technical Paper No. 465. Price, 15 cents.

One of the important functions of the Bureau of Mines is the analysis of samples of coal from every coal-mining State and from Alaska. These analyses are being published for the use of Government officials and the public. In connection with the analytical data showing the composition and quality of the coals of the States, consumers, producers, and the general public will be interested also in a brief description of the geologic structure of the coal basins, the typical mining conditions in the different districts, and the principal economic data of the industry.

HELEN M. STRONG.

Stamp, L. Dudley. *Asia, an Economic and Regional Geography.* 616 pp.; 322 illus. E. P. Dutton and Company, New York and London, 1929.

This volume is one of the first serious texts on the geography of Asia. Despite certain disadvantages of organization and balance, it is the best single reference book available and should find wide use in college classes and by the general reader. Asia as a continent has been singularly neglected by the modern interpretative geographer, partly due, no doubt, to the fact that so little is known of large areas. The wide-open spaces in the heart of Asia have been a convenient hiding place for many of the mysteries which still puzzle scientists, but the rising nationalism and increasing economic significance of the continent make it necessary that the West give attention to its geographic setting. To this end, Dr. Stamp has made a real contribution.

The book opens with seven brief chapters devoted to the continent as a whole in which the major outlines of the structure, climate, vegetation, population, and exploration are well presented. The last chapter in this part of the book includes numerous comparative diagrams showing Asia's share in world production.

The bulk of the book deals with the political units of the continent. In most cases these are discussed in terms of regions, but there is no unified description or map of the regions of Asia as a whole. Under each country there is a discussion of the physical features of the environment, such as the physiography, structure and climate, together with material on agriculture, and the population. The first chapter is entitled "Turkey—the Threshold of Asia," and is followed by "Arab Asia" and "The Iranian Plateau." In view of the fact that the author is most familiar with India, it is but natural that this chapter should be the most detailed. Nearly 200 pages are devoted to "The Indian Empire," more than half of which is made up of a survey of the 22 natural regions. Much of this material is taken from the author's earlier books, and is particularly valuable for its material on land utilization. This chapter occupies about one-third of the book, which would seem to be an undue share for India. This fact is partially justified because the book is written primarily for British students. The next two chapters are entitled "Ceylon" and "Southeastern Asia and the East Indies."

The good balance which the book shows thus far breaks down in the eastern and northern sections of the continent. "China," "The Dead Heart of Asia," "The Japanese Empire," and "Asiatic Russia" have but 150 pages together, and the analysis is less satisfactory than in the preceding chapters. In view of the size and population of China and the world position of Japan, it would seem that each one should receive at least as much space as India. Unfortunately no such wealth of statistics or maps is available for China as for India, but the author has not made complete use of the large amount of material in such publications as, for example, the *China Journal of Arts and Science* and the *Chinese Economic Journal.* The bulk of the chapter on China consists of material drawn from Roxby on regions; Baker, LaFleur, and Foscue on agriculture; Fisher on history; and other writers. This treatment does not lend itself to a unified or entirely true picture of the country. The dot map of rice distribution on page 463, for instance, does not show the abrupt northern limit of extensive rice culture, and its preparation on a hypsometric base gives a very erroneous picture of land forms in south China. The political treatment is in terms of pre-1911 provinces, and none of the maps are accurate for 1929. Numerous minor errors have crept into this portion of the book, many of which are perhaps unavoidable for one who has not travelled extensively in China.

The general arrangement of the book is factual rather than interpretative, and there is little direct attempt to show the relationship between man and his environment. The book contains 322 diagrams and maps, but no pictures. Many of the maps are without names or scales, and the use of solid black does not give very satisfactory results. The numerous references given in the footnotes are a distinct advantage. A very wide range of material is included in the book, and it fills a distinct need.

GEORGE B. CRESSEY.

Lippincott, Isaac. *Economic Resources and Industries of the World.* xxii and 635 pp.; maps and illustrations, index, and table of contents. D. Appleton & Co., New York, 1929. $5.00.

Economic Resources and Industries of the World is an up-to-date treatise on the world's crops, products, minerals, and other raw products, emphasizing the factors in their development and their world distribution. The purpose seems to be not only to provide a source book of information on the subject, but to emphasize throughout the work the ever-growing economic interdependence of peoples. He points out that economic penetration has become an established policy, not only for the further expansion of home industries, but for the development of the more backward regions to the point where they may yield their substances in abundance. The word "industries" is used in its broad sense and not in its narrower meaning which makes it synonymous with manufacturing.

A first glance at the contents and organization of the book reveals very little difference from many of our economic geography texts, but closer examination makes it evident that it emphasizes primarily economic matters, such as the effects of relative costs of production, the influence of the human factors in production, the effects of transplanted enterprises, financial power, ownership of ocean shipping, systems of trade, and historical development of trade; and deals subordinately with location and extent of resources, routes of materials to market, and the physical environmental conditions of development which the geographer would have emphasized.

Part I contains five chapters on discussions of the factors in the development of the resources and industries. Part II comprises eighteen chapters on distribution of world resources including minerals and metals, agricultural crops, livestock, vegetable oils, spices, forest resources, and petroleum. Part III discusses in nine chapters the resources and industries of certain countries, the names and page allotments to each being as follows: United States and Canada, 15 pages; Latin America, 15 pages; United Kingdom, 15 pages; British Empire, 16 pages; Germany, 13 pages; France, 13 pages; other European countries, 14 pages; and Asia, 16 pages. The final chapter discusses the Economic Prospect, bringing out the fact that industrial progress has brought with it the fear of exhaustion of resources, the discovery that resources are unevenly distributed over the world, and the realization that nature's scheme does not correspond to political boundaries. Trade must make good this shortage and these defects. It indicates that concern is unnecessary for certain materials that are inexhaustible or that can be replenished—water, soils, and forests—but that the real problem involves the waste and exhaustion of such resources as coal, iron, lead, zinc, and petroleum. The extent of this problem rests upon the extravagance of use, the actual amounts in reserve, and to a large extent upon the future contributions of human genius, improved methods of discovery and extraction which will make continued large scale consumption possible without unduly rapid exhaustion.

A fault of the book is its lack of adequate illustration. The total of 71 pictures, maps, graphs, and charts scarcely suffices for a book of 635 pages on such a subject. Also, on some of the world map illustrations, where the equal area projection is used, adapted from J. Paul Goode's Homolographic map, the parallels and meridians are omitted, diminishing their effectiveness.

Chapters of the book are well delimited in subject and the questions at the ends of chapters will tend to make the book more easily taught. Instructors in courses in Conservation, Foreign Trade and Investments, and Foreign Markets will welcome this book as a college text. Though more economic than geographic, the geographer will find in it much material of interest and help.

BERT HUDGINS.

Killough, Hugh B. and Killough, Lucy W. *Raw Materials of Industrialism.* xix and 407 pp.; 1 map and 55 tables and graphs; bibliography and index. Thomas Crowell Company, New York, 1929.

For a general introductory economic survey of the sources and uses of the world's supply of the most important raw materials, the Killoughs have contributed a piece of literature of at least passing value, not only to geographers, but to general readers as well. The authors make no pretense of dealing with the material, much of which they admit has been assembled by economic geographers, in a geographic manner but, instead, approach the subject from the economic point of view. Not only have the problems involved in keeping the world's factories supplied with raw materials been briefly but adequately discussed in the 407 pages of text, but an endeavor has also been made to assemble and interpret some of the obscure facts and unheralded currents of thought on the economic aspects of resources and industries that have been brought to light in recent years.

The book is divided into 22 chapters, the first chapter of which is concerned chiefly with the increasing significance of industrial raw materials in the advance and progress of civilization. "The advance of civilization," according to the authors, "is measured by man's mastery over his physical environment and the progressive evolution of doctrines, institutions, and artistic interpretations."

The next six chapters come under Part I of the book which deals with population and the world's food supply. The relationship of food supply to population has, from earliest times, occupied the attention of leading thinkers and philosophers. During the past one hundred years, the world's population has more than doubled. Thinly populated areas favorable for human habitation at present are rapidly being occupied in a surprisingly short time. The land pessimist's echoing cry of "Standing Room Only" is slowly but menacingly becoming proverbial. The growth of population in congested areas, if it is to continue, must shift from a point of very low productivity under conditions of intensive agriculture to one of higher per capita productivity in mining and manufacturing. The remaining five chapters are devoted to a discussion of the most important of the world's food products such as wheat, rice, maize, and other cereals; potatoes and sugar; meat and fish; dairy and poultry products; and finally, fruits and vegetables. The material under each product is divided roughly into the following topics: (1) History and importance in the world's diet; (2) Present demand and future requirements; (3) Producing regions and methods of production; and (4) Elasticity of supply. Under the history, a brief but satisfactory account of the past importance of each commodity is presented. Statistics and opinions of experts on the subject are used in discussing the present demand and future requirements of the product, and an effort has been made to avoid a too analytical frame of mind. Only a brief résumé of the most important areas in the world is attempted under the topic of producing regions and methods of production, and a very excellent and satisfactory bibliography included at the end of the book for those wishing to peruse or study further into the subject.

Part II, devoted to textile fibers, consists of three chapters, one on cotton, one on wool, and one on silk and rayon together.

Similarly, Parts III, IV and V, devoted to the crude products of the forest, metals and sulphur, and fuels and power, include chapters on wood, rubber, gold and silver, sulphur, copper, iron, coal, petroleum, and water power. The method of treatment is in many ways the same as that for the food products.

Part VI emphasizes the interdependence of nations for raw materials and calls attention to the fact that in weaving patterns of economic philosophy about a few selected raw materials, there is a danger of oversimplifying the subject and narrowing the vision so as to exclude some of the minor materials like steel alloys which are just as essential to the efficient operation of the world's greatest manufacturing industries. A brief mention of some of these commodities would include manganese, nickel, cobalt, chromium, antimony, tungsten, vanadium, tin, fertilizers, hides and skins, hemp and sisal, rattan, chicle, bristles, asbestos, shellac and jute, and a score or more of other minor materials.

Part VII, containing the remaining chapter, deals primarily with the influence of raw materials upon economic thought and practice.

The book contains one colored map of the world hidden away in the back of the book, too small and too highly generalized to be of any particular value, and 55 charts and tables which, considering the scope of the work, might be accepted as sufficient. The most commendable feature is the very excellent bibliography that is provided at the end of the book. Almost 400 separate references are listed included in which are some of the best and most valuable titles on the subject of raw materials that are in print today.

ANTHONY J. WEST.

Wolfanger, Louis A. *The Major Soil Divisions of the United States.* 150 pp.; 6 tables; 1 map. John Wiley and Sons, Inc., New York, 1930. $2.00.

As the title states, this book deals with the major soil divisions of the United States. His classification of soils and his method of treatment follow those of Dr. Curtis F. Marbut, with whom the author was for several years associated, though he uses a number of new terms in contrast with Marbut's well-known reluctance to burden the new soil science with a wholly new terminology.

The book consists of four chapters: namely, "Major Soil Divisions and Their Geographic Qualifications"; "The Pedalfers"; "The Pedocals"; and "Geographic Relationships." The one map locates the major soil divisions and the great soil groups of the United States.

In the first part of Chapter I the author classifies the soils as members of one of two systems: (1) the genetic, in which the relationship of the factors producing the soil are employed as criteria, and (2) the attributive, in which the soils' own attributes or features serve as a basis. The genetic factors are geology, climate, botany, and topography. The attributes of the soil are chemical composition, color, texture, and maturity. The last part of the chapter deals with the great soil groups—(1) the Pedalferic groups which include the Podsols, the Gray-Brownerths, the Red-and-Yellowerths, the Ferruginous Laterites, and the Prairyerths; (2) the Pedocalic groups which include the Blackerths, the Chestnuterths, the Brownerths and the Greyerths, and (3) the Rough Broken Land.

The Pedalfers are described in Chapter II and the Pedocals in Chapter III. In each chapter the author shows first the influence upon the soil of the environment—climate, natural vegetation, parent material, and land forms; and second, how the chemical and physical properties change the soil. The Prairyerths are considered apart from their allied groups in Chapter II, because they present such a striking contrast with the typical Pedalfers.

In the last chapter he points out how the two major soil divisions differ. The relatively infertile Pedalfers form the leading agricultural group, with the greater crop diversity. Forests dominate the natural vegetation of this group but with settlement, silviculture is governed more by economic than environmental conditions. The Pedocals while comparatively rich and of high fertility, are doomed by their relatively deficient rainfall principally to pastoral use, agricultural adjustments being confined to their moister peripheries.

Mr. Wolfanger has succeeded in putting before his readers the major soil divisions with their fundamental characteristics and in showing the essential and more geographic relationships of each division, a service which geographers have long awaited; but his disposition to introduce new terms that are unusual and must be defined, justifies a word of warning against multiplicity of new terms and consequent involved terminology such as has retarded the progress of ecology rather than promoted its advance.

ROSE ZELLER.

Douglass, Harlan Paul. *The Suburban Trend.* xi and 340 pp.; 25 charts. The Century Company, New York, 1925.

As the title indicates, this book is devoted to a study of the suburb in relation to the city. It follows a study made by the same author in his volume on "The Little Town" (1919). The first volume interpreted the town as a sort of half-way house between country and city, but the present volume has been compelled to conclude that the suburbs, in the main, are intermediate in form rather than in significance. In essence they are parts of the evolving cities and in sharp contrast with the original rural pattern of social experience.

In the opening chapter of the book the author has taken several cities and has described and analyzed them showing (1) that its magnitude is generally proportionate to the congestion of the city center, and (2) that its relation to the city tends to vary directly as its distance from that center. In the following three chapters, he indicates the present extent of cities and their growth, how they vary and why.

Beginning with Chapter V, the author discusses the economic factor or the cost of suburban living. He states two main reasons why more people do not live in the suburbs: first, because they do not wish to live away from the city, and, second, because they cannot afford to. He goes further by indicating how these costs are met by those who do commute.

To give a concrete example of the development of a suburb, the writer has selected Webster Groves, Missouri, a residential suburb of St. Louis, with a population of about 10,000, almost exclusively American born. In this study he considers any special or distinctive characters of the suburban family; the occupation of the commuters and their prestige in the community; the handicap in natural leadership because it has no independent rural area to serve; the divided loyalties of the professional group; the deficiency in social institutions such as libraries, parks and playgrounds, a community center or any substitute for one like a Young Men's or a Young Women's Christian Association; and other public improvements which are pert to a live progressive community. Many of the things which he finds lacking in a suburban community can be found in a rural community which has grown more slowly so that these institutions have been able to keep up with the growth of the town.

A few things, however, can be said in favor of the suburban centers. Athletic clubs have often taken the place of the Christian Associations; schools are developed after the system of the city, but a larger proportion of the tax bill goes to education than in the parent city; the land is cheaper than in the crowded city districts; methods of living are somewhat improved over many city districts; and there are greater opportunities for the family to enjoy nature and recreation.

A rural element in suburban life is an important factor in many homes. Many families can keep a few chickens, a cow, and work a small area of land in which they raise many of their own vegetables, thus saving considerable in the household expenses. Several cases have been studied which show that the influence of the city decreases with increasing distance from the city. More land is devoted to trucking near the city, farms are smaller, dairying less important, but rents are higher.

In conclusion, the writer expresses the opinion that in the future most of the area of the nation will be covered with villages and farm lands such as one now finds in the more thickly populated portions of Europe and that most of these villages will be clustered about minor centers which, together with them, constitute the suburbs of cities of moderate size. Here much of the work, as well as the recreational interests, of the people will lie. With this increase of suburbanization there must be an increased knowledge and understanding of city planning which will care for the increase of population. In a great measure the hope of the future city lies in its suburbs.

HARRY K. HUTTER.

Huntington, C. C. and Carlson, Fred A. *Environmental Basis of Social Geography.* xxix and 486 pp., maps, charts, illustrations, bibliography, and index. Prentice-Hall, Inc., New York, 1929. 9 x 6 inches. $4.00.

Environmental Basis of Social Geography is an intriguing title but none the less a misnomer. It might better be "Social Geography" only, though even that title would be warranted merely in part. Certainly the book endeavors to include not only the "basis" but much of the "superstructure" of Geography as well. The "Environmental Basis" is inadequately and ineffectively, even superficially, treated, if, as the title suggests, this were the theme of the book; the "Social Geography" is likewise unsatisfactorily treated, though a goodly part of the text appears to be devoted to that elusive (perhaps illusive, or delusive, would be better) subject if economic geography, and to a lesser degree, political geography, and goodness knows what else (see page 15 of the book) be considered "social."

As an elementary introduction to the field, prepared expressly, as the preface states, for "college and university students beginning the old subject of geography," the book would better not have included, certainly not as the first chapter at any rate, the indefinite and apparently indefinable "nature and classification of geography." So much that is doubtful, or controversial, is set down as gospel in the first chapter that it is hard even for one who agrees in the main with the burden of argument and definition in the chapter to submit without protest against such dogmatic finality. To impose it upon the innocent undergraduate, unprepared to evaluate the arguments or follow their direction, seems unjust and unjustified. Perhaps at the end of the book he might be unwilling to accept the dogma laid down in the first chapter!

The book covers a wide, wide field! To cover this wide field within five hundred pages, it must be well organized and extraordinarily compacted; it must discriminate well between essentials and non-essentials, and discard all of the latter and some of the former; it must outline rather than elucidate—and these things it does remarkably well. It includes a wealth of suggestive material —the faculties of the collegiate departments who will be called upon to consider it for their classes must decide for themselves whether or not it is suitable, and whether or no it is conveniently and wisely presented.

The book is bound well. The type is easy to read. Some of the illustrations are so blurred as to be valueless. The style in places is clear and pleasing, in others labored and heavy. The bibliography is rather well selected, and valuable. A mixture of good, bad, and indifferent, spread wide and in places thin—that is *Environmental Basis of Social Geography*.

W. ELMER EKBLAW.

Andrews, Roy Chapman. *Ends of the Earth.* 355 pp.; ills. Printed for the National Travel Club by G. P. Putnam's Sons, New York, 1929.

Between the youthful Roy Chapman Andrews shooting birds in the Wisconsin woods and the famous naturalist and explorer digging out dinosaur eggs in the Gobi Desert lie thousands and ten thousands of adventurous miles. *Ends of the Earth* is his remarkable story of the span of years that those miles filled; years that he spent traveling the world over to collect specimens of mammals, birds, and fossils for the American Museum of Natural History.

When Mr. Andrews first came to New York in 1906 just after graduating from Beloit College, he accepted the lowly work of scrubbing the floors of the American Museum in order to be ready for subsequent loftier tasks. Opportunity came in the form of building a seventy-six-foot model papier-maché whale and in bringing in the bones of an "honest-to-goodness" whale from a Long Island beach. The success of both of these efforts caused the Director to ask him to describe the whale for the Museum.

The scarcity of references showed him how little was known of whales, and he determined to find out more about them. With just his expenses paid he set out for Vancouver Island and the Alaskan coast. From his observations there and across the Pacific he gives a lively account of whales and whaling ending with the discovery of the supposedly extinct California grey whale on the coast of Japan.

Most of the remaining two-thirds of the book Mr. Andrews devotes to his explorations and life in the Orient. Collecting as he went, he has traveled from the jungles of the East Indies to the desert interior of China. Queer things happened to him everywhere; he fortunately escaped a writhing python in Borneo and poisoned traps in Malaya, only later to have a peaceful meal with Chinese bandits.

Convinced of the possibility of gaining valuable records of past ages in the interior of Asia, Mr. Andrews returned to this country to organize an expedition. He presented his beliefs and plans so enthusiastically and forcibly that he at once received the backing of the American Museum and some New York financiers. The work of the Gobi Desert Expedition with the exception of a casual mention of the finding of the dinosaur eggs is omitted due to the fact that another book of his tells that story. Instead of the expected trip into the heart of Asia Mr. Andrews tells of the social life in the foreign circle in old Peking. He writes with interest of polo ponies and Chinese cooking, yet he laughs at the tragic political situation and makes fun of the old religion. His apparent lack of sympathy for the Chinese people is regrettable.

The final chapter is an evaluation of the American Museum of Natural History and its scientist. Mr. Andrews pays special tribute to Dr. Carl Akeley of African fame, to Dr. Frank Chapman, the Curator of Birds, to Dr. George L. Sherman, the Director of the Museum, and to Dr. Henry Fairfield Osborne, its President. In concluding, he expresses his endless belief in the work of the Museum in placing natural history within access of the public.

To those who, like Mr. Andrews, feel "the lure of new lands," *Ends of the Earth* offers vicarious exploration and great enjoyment. Although somewhat sensational and fragmentary, it is a good narrative of a style and content which demand that it be taken lightly.

REBECCA M. TALIAFERRO.

Wills, L. J. *The Physiographical Evolution of Britain.* viii and 376 pp.; 2 plates; 154 sketches, maps, and diagrams. Edward Arnold & Company, London, 1929.

Dr. Wills has contributed to geological student literature a textbook in a new field, the physiographic evolution of former land surfaces. The contributions of paleogeographers, *i.e.*, "the distribution of land and sea, the general climatic conditions and the type of life at the different periods," form the background of the picture. In the foreground the author has tried "to place the physiographic processes that were at work in those surroundings, moulding and modifying the surface of the earth from period to period in those far-off days."

The book is divided into three parts, of which the first deals with Basic Principles, the second with the relatively simple Post-Carboniferous Systems, and the third with the much more complex Pre-Cambrian and Paleozoic Systems. The second and third parts follow the stratigraphic order except that volcanics are considered by themselves in a final chapter.

The organization of Part I is sufficiently unusual to justify its inclusion here.

Part I
- Principles of Physiography
  - Subterranean Processes of Change
    - Diastrophism, Vulcanicity, Metamorphism
  - Surface Processes of Change
    - Denudation
      - Generalizations, Humid Climates, Dry Climates, Glacial Climates, Marine Erosion, The Geographical Cycle Under Humid Conditions

Deposition
 Continental Deposits
  Mechanically Formed, Organically Formed, Chemically Formed
 Marine Deposits
  Generalizations, Neritic Zone, Bathyal Zone, Abyssal Zone
Principles of Stratigraphy or Historical Geology
 The Nature of the Geological Record

This part of the book is largely an enumeration and is intentionally incomplete, for throughout Parts II and III the characteristics of environmental forms are introduced or accompanied by a consideration of their physiographic causes. For instance, "The tendency for the floor of a geosyncline to buckle in places during the cycle of sedimentation that fills it up, is recorded by . . . unconformities with the Ordovician" . . . "the direction of these unconformities . . . in the Lake District seems to have been N.N.E." and further ". . . vulcanism usually accompanies the movements connected with a geosyncline. This is strikingly illustrated in the Ordovician."

Thus it appears that the author felt the need of Part I to set the stage, but tried to save his thunder for Parts II and III. The varying intensity, combination, and sequence of the physiographic processes in the past have left a record that is here presented as a series of landscapes, each explained by "the *study of processes* (author's italics) that is our primary object in this book."

The book is necessarily technical, but the author is very careful to cite examples and has provided a generous number of illustrations in black and white. The maps and diagrams are uniformly excellent, though some would be improved by the addition of a scale. No photographs are included. The author has chosen to sketch from borrowed pictures in a manner not always as effective as the other illustrations, pages 25, 110, and 111.

The trick of comparing former landscapes to analogous present vistas helps to visualize conditions. For instance, "The Aralo-Caspian Basin, together with North Persia and Turkestan, offers many features for comparison with the late Carboniferous and Permian geography of North-West Europe"; and again, "Probably the South China Sea with its varying depths and currents, muddy river mouths and coral-girt islands offers, as far as conditions governing deposition are concerned, the best present-day analogue to the Jurassic and Lower Cretaceous seas of Western Europe; the deeper-water deposits of the Upper Cretaceous were possibly formed under conditions . . . nowhere . . . paralleled at . . . present. . . ."

The book is attractively bound and printed and presents a difficult subject quite interestingly. It is of more interest to the British than to others because of the strictly local application of many of the principles, though the evolution of Europe is concurrenlty outlined. The rather detailed subdivision of the geological column and the English naming of the epochs further reduce the value as a reference to those American geographers who are not also stratigraphers. However, no geographer can read the volume without a new conception of the vicissitudes of the physiographic ancestry of Britain and of Europe.

MEREDITH F. BURRILL.

Newbigin, Marion I. *A New Regional Geography of the World.* xix and 432 pp., 57 sketch maps and diagrams, 29 illustrations, index, and questions. Harcourt, Brace & Company, New York, 1929.

"Is it possible, within reasonable limits, to take a world survey which shall combine a broad outlook with sufficient study of detail in regard to the more important areas to add interest and check hasty generalization? This is the problem which this book attempts to solve. . . ."

The book is divided into seven parts, one to each of the continents, and a final section entitled "Some Notes on Geographical Inter-relations." In Part I, consisting of 144 pages, Europe and its margins are considered. A general survey of Europe is given in the first chapter, and in the remaining seven chapters, sections of Europe are comprehensively treated as to structure and relief, natural vegetation, climate, resources, and human relations. In the treatment of all the European countries except Russia, structure and relief are almost overemphasized. That this was the intention of the author, however, is apparent, for in the introduction the statement is made that "great emphasis has been laid on these subjects, because in this way the key is given to the interpretation of . . . maps" and "the foundations laid on which more detailed knowledge can be built as the need or occasion arises." The chapter treating Russia and the new states, and that on Mediterranean Europe and its margins, though relatively brief and concise, contain much important information. The physical structure, plant cover, stages in growth, and new states of Russia are considered. In the Mediterranean region, the range of climate, crops and products, trade and exports are treated, followed by a discussion of the structure and relief of the various countries.

Four chapters, totaling 65 pages, are devoted to the continent of Asia. The position, structure and relief, natural regions, climates and political units are included in the general survey. Two chapters are given to the Monsoon Lands, one the Indian Empire and Ceylon, the other China, Japan, Indo-China, and the Malay Archipelago. The remaining chapter is a discussion of lands outside the monsoon belt. Asia is well treated, some political and historical material being included in relation to the geographic.

Part III, Africa, also contains four chapters with a total of 47 pages. A general survey is first given, then the divisions of northern, equatorial, and southern Africa are discussed under topics similar to the above. Although the author states that "no rigid consistency of treatment throughout has been attempted" the topics included under each section are, of necessity, similar.

North America, Part IV, is treated in a manner somewhat different from that of the other sections. A general summary is first given, then Canada and Newfoundland are discussed as to area and divisions, distribution of population, resources and their distribution, and lines of communication. The treatment of the United States includes more of the historical than the discussions of the other sections, and Chapter 20 is a series of regional studies of the United States. The concluding chapter of the section takes up Mexico, Central America, and the West Indian Islands.

Two chapters are devoted to South America, the first a general survey and the second a discussion by states. Thirty pages are given to South America, while 32 pages are given to a discussion of the structure and relief, drainage and artesian water, climate, plants and animals, people, pastoral and agricultural produce, minerals, and lines of communication of Australia, New Zealand, and the Australasian Islands.

Part VII, the final section of seven pages on geographical inter-relations, discusses sites of towns and localization of industries. These are given as examples, showing how to work out a problem in order to explain a geographic fact.

The graphs and tables are comprehensive; the illustrations are numerous and well chosen; the relief and structure and vegetation maps are easily understood; however, some slight changes in the maps showing cultural features might make them more easy to understand.

The index of seven pages seems very complete. The last seven pages of the book are devoted to questions, divided according to the continents which they concern. These questions are diversified and thought-provoking. Some are simple questions, others call for answers which are comparative, descriptive, or expository.

The aim of the author to present a study of the structure, relief, vegetation, climate, resources, transportation, trade, and people of the regions of the world in a concise and interesting way has been accomplished. The book is excellent for reference or for use as a text in an elementary course of college geography.

VINA E. SPENCE.

ANNOUNCEMENT

THE series on the *Agricultural Regions of Australia*, by Dr. Griffith Taylor, begins in this issue and Dr. O. E. Baker contributes another instalment of his *Agricultural Regions of North America.*

Agricultural Regions of Africa, by Homer L. Shantz of the University of Illinois and president-elect of the University of Arizona; and *of Asia*, by Samuel Van Valkenburg of the College of the City of Detroit will follow in later issues to complete the finest geographic discussion of the world's agriculture thus far published.

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The January issue of Volume 6 contains the following articles:

Agricultural Regions of South America, Clarence F. Jones, Clark University.
The Potato Industry in Nebraska, Esther S. Anderson, University of Nebraska.
Agriculture in the Dry Region of the U.S.S.R., N. M. Tulaikov, Agricultural Experiment Station, Saratov.
The German Sugar Beet Industry, E. Muriel Poggi, University of Illinois.
Divisions of the Pine Forest Belt of East Texas, William T. Chambers, Stephen F. Austin State Teachers College.

The October issue of Volume 5 contains the following articles:

Geography's Part in the Plant Cost of Iron and Steel Production at Pittsburgh, Chicago, and Birmingham, Langdon White, Randolph-Macon Woman's College.
Readjustments in Post-War Cotton Culture, Earl C. Case, University of Cincinnati.
Tung Oil: Florida's Infant Industry, M. Ogden Phillips, Formerly, University of Florida.
The Farm Problem, Robert Stewart, University of Nevada.
Forest Regeneration in Porto Rico, William D. Durland, Formerly, University of Porto Rico.
The Topographic Map of the United States, Guy Elliott Mitchell, U. S. Geological Survey.
Agricultural Regions of South America, Clarence F. Jones, Clark University.

July includes:

Canada's Advance to Hudson Bay, Harold S. Patton, University of Cincinnati.
Economic Conditions in St. Vincent, B. W. I., G. Wright, Imperial College of Tropical Agriculture, Trinidad.
Economic Geography of the Hawaiian Islands, Otis W. Freeman, State Normal School, Cheney, Washington.
Agricultural Regions of South America, Clarence F. Jones, Clark University.
Iron and Steel Industry of the Cleveland District, John B. Appleton, University of Illinois.

April includes:

Agricultural Regions of South America, Clarence F. Jones, Clark University.
The Potash Industry of Europe, Fred S. Mohme, University of Illinois.
The Sugar Industry of the British West Indies and British Guiana with Special Reference to Trinidad, C. Y. Shephard, Imperial College of Tropical Agriculture.
Iron and Steel Industry of the Middlesbrough District, John W. Frey, University of Wisconsin.
The Grape Industry of Spain and Portugal, W. O. Blanchard, University of Illinois, and Elizabeth R. Blanchard.
The Philippine Lumber Industry, Luis J. Borja.

January includes:

Industrial China, H. F. James, Wharton School of Finance and Commerce.
Land Resource Inventory of Michigan, Carleton P. Barnes, Michigan Land Economic Survey.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.
Scranton's Industrial Integrity, Clifford M. Zierer, University of California at Los Angeles.
A Critical Situation in Two One-Crop Wheat Farming Districts in California, John W. Coulter, University of Hawaii.

The October issue of Volume 4 contains the following articles:

Fisheries of the South Atlantic and Gulf States, J. H. Matthews, Atlantic Coast Fisheries Company.
The Iron and Steel Industry of the Birmingham, Alabama, District, Langdon White, Randolph-Macon Woman's College.
America's Resources in Nitrogen, Potash and Phosphorus, Guy E. Mitchell, U. S. Geological Survey.
Possibilities of Rubber Production in Caribbean America, Jewell Venter, University of Missouri.
The Kentucky Geographical Surveys: A Review, W. Elmer Ekblaw, Clark University.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.

Single copies of back numbers of Volumes 1 and 2, 1925 and 1926, will be sent to any American address for $1.75 each; to any foreign address for $2.00. Back numbers of Volume 3, 1927, Volume 4, 1928, and Volume 5, 1929, will be sent to any American address for $1.50 each; to any foreign address for $1.75. Whole volumes may be obtained at the yearly rate.

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JULY

AGRICULTURAL REGIONS OF AUSTRALIA
Griffith Taylor, *Professor of Geography,* University of Chicago

THE PASTORAL AND AGRICULTURAL INDUSTRIES OF KENYA COLONY AND PROTECTORATE
Earl C. Case, *Geographer,* University of Cincinnati

ECONOMIC ADJUSTMENTS IN BAVARIA
Hubert A. Bauer, *Associate in Geography,* University of Washington

AGRICULTURAL REGIONS OF NORTH AMERICA
ver E. Baker, *Senior Agricultural Economist,* U. S. Department of Agriculture

THE FOREST OF DEAN IN GLOUCESTERSHIRE
E. Muriel Poggi, *Geographer,* University of Illinois

RK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.A.

OUR CONTRIBUTORS

Dr. Taylor, professor of geography at the University of Chicago, contributes the last instalment of *Agricultural Regions of Australia*, a part of the series on the *Agricultural Regions of the World* published by ECONOMIC GEOGRAPHY. A geographer of note, he is familiar with various phases of geography of Australia. From 1920 to 1928 Dr. Taylor was head of the department of geography at the University of Sydney, and during 1927 and 1928 he was president of the Geographical Society of New South Wales. Dr. Taylor has written a great number of books on geography and related subjects, one of which, "Environment and Race," was reviewed in a previous issue of ECONOMIC GEOGRAPHY.

Dr. Case, now associate professor of geography at the University of Cincinnati, spent the summers of 1922–1924 with the Tennessee State Geological Survey. In 1925 he received his Ph.D. degree at the University of Chicago, and was connected with the Resource Survey of the University of Cincinnati from 1925–1927. He has written several papers including "Relationship of Industry to Environment in the Valley of Eastern Tennessee" for the Tennessee State Geological Department at Nashville, and "Forests and Forest Industries of Marine Regions" which appeared in the Bulletin of the Geographic Society of Philadelphia, July, 1929, issue, pages 213–234.

Dr. Bauer, who is at present associate in geography at the University of Washington, is a graduate of the University of Munich. He has done graduate work at the University of Greifswald and the University of Washington, having received both the M.S. and Ph.D. degrees from the latter university. Mr. Bauer has written a series of geographic articles on "Human and Economic Geography of the United States," published by the Bavarian newspaper syndicate, "Bayrischer Zeitungsblock" in Munich.

Dr. Baker, senior agricultural economist with the U. S. Department of Agriculture, contributes Part VIII of the series of articles on the "Agricultural Regions of North America." He has been in charge of the preparation of the *Atlas of American Agriculture*, and in 1923 was chairman of the Yearbook Committee of the Department of Agriculture. He is the author of several agricultural bulletins, and joint author, with Dr. V. C. Finch, of the "Geography of the World's Agriculture." His publications relative to agricultural resources and their utilization have appeared in the agricultural yearbooks, in the *Annals of the Association of American Geographers*, in the *Geographical Review*, and ECONOMIC GEOGRAPHY.

Miss Poggi is instructor in geography at the University of Illinois where she took her M.A. degree in 1928. She hopes to receive her Ph.D. degree in June, 1931. She trained in geography at the London School of Economics, University of London. Her paper in this issue is the result of personal field work, as was also her article on the "Red Land of Gwent" in a previous issue.

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PLATEAUS

THE plateaus of the world have played a prominent rôle in the evolution of human culture. Whether or no they constitute the cradle of the human race, they certainly have formed one of man's chief training-schools where he learned to defend himself from the brutes who would have made him their prey and from the forces of nature that buffeted him from day to day or from season to season. They have given him the impetus to individualism within the social or community group and lent him the inspiration of their altitudes and wide horizons for monotheistic, idealistic religion. They have forced upon him thrift and frugality, courage and independence.

In the history of the races that bear highest the torches of modern civilizations, it is the Eurasian plateaus that impressed upon the character and culture of the Caucasian and Mongolian races the indelible stamp of their rigorous winters, their glorious summers; their pastoral valleys, their forested slopes; their advantageous points of view, their illimitable horizons. How deep is the imprint upon the ancient foundations of the oriental and occidental peoples of Asia and Europe of the stern and inexorable snows, the verdant grasslands, the stony piedmont paths of the Pamirs, the Caucasus, the Carpathians, and the Alps!

And wherever these peoples have emigrated to America, to Africa, to Australia, the plateaus play the same powerful rôle, whether it be in the Laurentian or Appalachian uplands of eastern North America; the Andean heights of South America; the table-lands of Rhodesia, Uganda, or Kenya in Africa; the high flats of eastern Australia. Economically, politically, culturally they have shaped the destinies of the future.

ECONOMIC GEOGRAPHY

VOL. 6 JULY, 1930 No. 3

AGRICULTURAL REGIONS OF AUSTRALIA*

INSTALMENT II

Griffith Taylor
Professor of Geography, University of Chicago

SOILS

VERY little work of a comprehensive nature has been done upon the soils of Australia, except in New South Wales, where several chemists (notably Jensen and Guthrie) have described many varieties (Fig. 29). The following account is based largely on the book (1914) by the former. Jensen describes the soils in terms of Tulaikov's classes as follows:

Tulaikov	*Jensen's Name*	*Locality*	*Uses*
1. Laterite soils	Red basalt soils (scrublands)	Northern coastal rivers Eastern slopes	Dairying, roots, fodder
2. Loess	Red soils	Nyngan and red western plains	Wheat belt (white box and buddah)
3. Dry steppe (alkaline)	Saltbush country	Cobar, Bourke, and West	Arid pastoral (saltbush)
4. Tchernozem (lime and humus)	Black soil plains	West slopes and plains	Agriculture, maize, pasture
5. Forest steppe (gray and leached)	Eucalyptus forest lands	Coast and tablelands	Fruit and farming
6. Podzol (peats and organic acids)	Drained swamps	Coasts and tablelands	Pasture, crops, when drained
7. Fenland	Cold tableland	Kosciusko	Summer pasture

The north-coast soils are a fine series. The basalt soils are very similar to the leached soils of Madagascar and India.

The region around Sydney is a hungry Triassic sandstone which produces very poor soil. Behind Newcastle the Hunter River flats are built up of a rich soil as the river passes over a diverse series of rocks. The south-coast soils are better than those of the southern tablelands for large areas of basalt occur, while the granites are less siliceous on the coast. The South-West Slopes are also superior, since the soils are less leached and the granites richer in useful salts than those of the Southern Tableland. The latter, however, has an area of basalts in the Monaro region.

As regards the three tablelands (north, center, and south) the soil improves to the north, because the granites become more basic. Limestones abound in the western flanks, which produce good soil. The north is moister and warmer, and so similar soils (*e.g.* basalt) produce better crops in the north than in the south of the highlands.

All the western soils are richer in plant food than the others, since leaching is reduced to a minimum. But many types have such an accumulation of salts that they become alkaline. They consist of three classes: (1) good black soils, (2) fair red soils, and (3) poor light gray soils.

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* The author wishes to correct two slight errors in Instalment I. Page 109, rainfall table, South America, should read "Largely *hot;*" page 126, Tasmanian map, "uninhabited land" contains a few small mining towns.

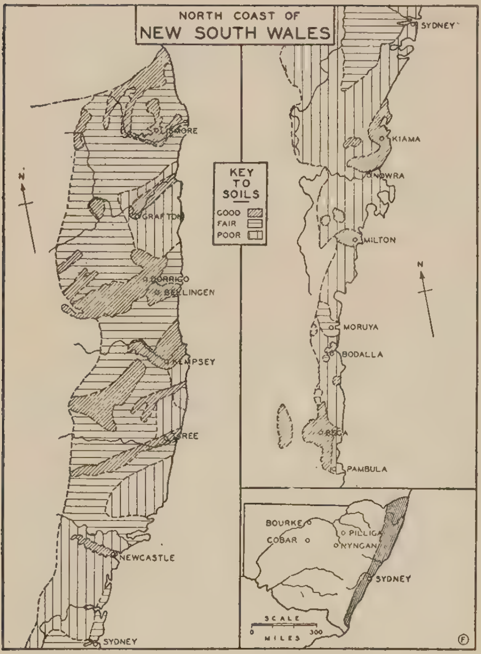
NORTH COAST OF
NEW SOUTH WALES
LISMORE
GRAFTON
DORRIGO
BELLINGEN
KEMPSEY
TAREE
NEWCASTLE
SYDNEY
KEY TO SOILS
GOOD
FAIR
POOR
N
SYDNEY
KIAMA
NOWRA
MILTON
MORUYA
BODALLA
BEGA
PAMBULA
BOURKE
COBAR
PILLIGA
NYNGAN
SYDNEY
SCALE
0 MILES 300

FIGURE 29.—Little work has been done upon the soils of Australia except in New South Wales, where H. I. Jensen has described and mapped the soils according to Tulaikov's classification as indicated in part on this map, and in the accompanying table. The south coast is also shown here.

The Black Soil Plains are widespread near the northern rivers (Gwydir, Namoi, etc.) flowing into the Darling. They are generally of basaltic derivation and are very sticky when wet. Organic matter in the alluvials amount to 7 per cent. They are poor in nitrogen and humus as compared with Russian black soils, but in phosphoric acid are among the best in the world. They are uniformly deep.

The Red Soil Plains are very variable. The best are on hilly country and are derived from basalt under oxidizing conditions. All rocks in the west which are not very poor in iron (and not situated in a *basin*) yield red soils, for the paucity of organic matter allows for a rapid oxidation of the iron in the clay. This accounts for the great extent of the Red Soil Plain. Such soils are abundant in the Riverina, where, however, they are derived from Tertiary rocks of a calcareous or shaly composition.

The associated trees are given in the table below (also from Jensen).

MURRUMBIDGEE IRRIGATION AREA

In much the same environment as that of the western irrigation areas of the United States, a group of similar projects has developed in Australia. The rainfall falls off rapidly to the

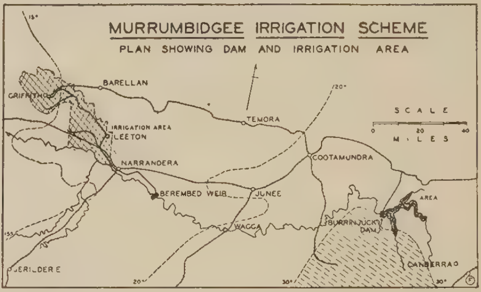
MURRUMBIDGEE IRRIGATION SCHEME
PLAN SHOWING DAM AND IRRIGATION AREA
15°
BARELLAN
GRIFFITH
IRRIGATION AREA
LEETON
NARRANDERA
TEMORA
120°
SCALE
0 20 40
MILES
COOTAMUNDRA
BEREMBED WEIR
JUNEE
WAGGA
BURRINJUCK DAM
AREA
CANBERRA
JERILDERIE
20°
30°
30°

FIGURE 30.—The Murrumbidgee Irrigation Project is the most ambitious thus far completed in Australia. (Based on map by the Dept. of Lands, Sydney.)

Soil	*Locality*	*Timber, Etc.*
1. Hawkesbury sandstones	Sydney	*Eucalyptus eugeniodes, E. corymbosa, E. saligna, E. pilularis, Casuarina sp., Angophora, Acacia suavolens.*
2. Wianamatta shale	Sydney	*E. hemiphloia, E. crebra, Melaleuca, Acacia decurrens, Syncarpia* or a mixture of 1 and 2.
3. Rich volcanic soil	North Coast	*Cedrela, Araucaria, Doryphora, Tristania.*
4. Poor western sands	Pilliga	*Callitris calcarata, Casuarina glauca, E. haemostoma.*
5. Black soil plains	Northwest Slopes	*Acacia pendula, E. Woolsiana, E. melanophloia.*
6. Heavy red soils	Nyngan Riverina	*Geijera, Acacia homalophylla, Casuarina.* *A. Cambagei.*
7. Poor red soils	Cobar Darling Basin	*E. populifolia, Eremophila, Dodonea.* *E. intertexta, Acacia aneura.*

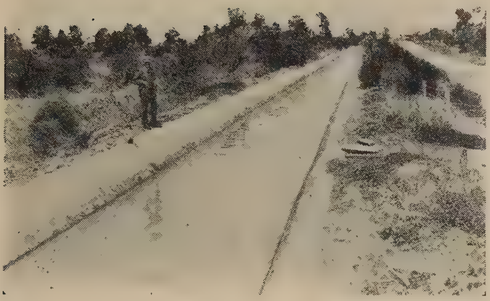

FIGURE 31.—One of the numerous irrigation canals in South Australia, diverting water from the River Murray. (Courtesy of South Australian Govt., Intelligence and Tourist Bureau.)

west (see Fig. 30), and it is only possible to obtain large crops by supplementing the rainfall. The largest completed scheme impounds the water of the Murrumbidgee—but the Hume dam near Albury on the larger stream of the Murray will exceed it in importance.

The amount of land in the western plains suitable for irrigation is immense, but the scanty water supply in the rivers limits irrigation to a few favored localities. Near Yanco it is proposed to irrigate 250,000 acres ultimately by means of the large dam at Burrinjuck some 300 miles up stream from Yanco. Here, a deep gorge in the block-mountain region lends itself to such a structure.

The Burrinjuck Dam impounds about 13,000 acres,[9] and sends the water back up the river for 40 miles. The water passes through sluices into the river bed and so reaches Berembed weir, some 240 miles away in the plains country. The weir diverts the water to the north and a canal of 40 miles takes it to the irrigation area at Yanco. The first settlers arrived in 1911, but the war hindered progress. However, several thousands of farmers are now flourishing in a region which formerly only carried sheep; and it is hoped that the total population may ultimately reach 100,000. Nearly every kind of temperate and semi-tropical fruit grows most luxuriantly—apples, peaches, oranges, almonds, figs, as well as all kinds of grapes. Rice, cotton, tobacco, and peanuts promise well. All kinds of cereals flourish, but lucerne (alfalfa) has not done well so far.

Ten to twenty acres is the usual size of a fruit farm and 50 to 100 acres for dairying and mixed farming. Butter, bacon, cheese, and fruit-canning factories are established, and small towns have sprung up over the area. Leeton in the southeast, and Griffith in the north are the chief centers, the latter being perhaps the most progressive. These are linked to the east by two railway lines.

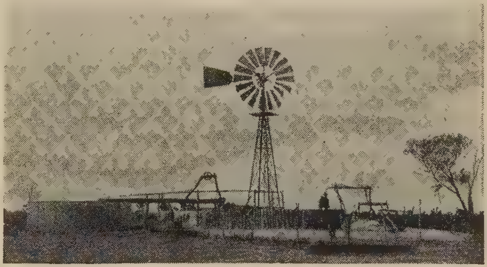

FIGURE 32.—In the utilization of the underground water supply, the equipment for raising the water has undergone an interesting evolution from the windlass well in the foreground, to the "horse whip" in the background, to the government windmill. Taken near Kingoonya, South Australia, in a region of 9-inch rainfall; by the author.

IRRIGATION IN VICTORIA

In 1887 Chaffey Brothers installed pumps at Mildura on the Murray with which they irrigated 12,000 acres, and this method of water supply has been adopted at a number of small settlements along the lower Murray, especially in South Austra-

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[9] Based on an account by Professor R. D. Watt (Pan Pacific Science Congress, 1923).

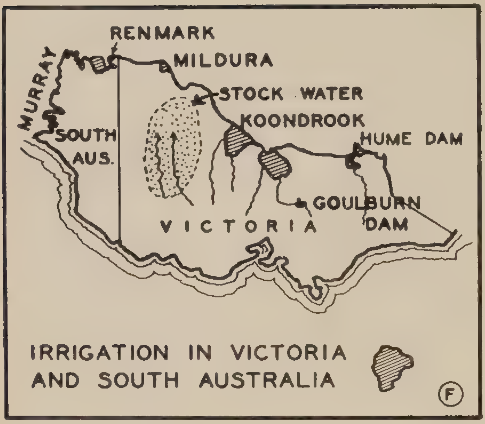

FIGURE 33.—Irrigation in Victoria and South Australia is an important factor in the advancement of agriculture and settlement.

lia. Occasionally in droughts as in 1902 and 1922, the big river ceases to flow and to prevent such occurrences a large dam is being erected above Albury where the Mitta Mitta River joins the Murray. The Hume Dam will store over one million acre-feet and there are being constructed by the Commission about 35 weirs and locks on the lower Murray and Murrumbidgee.

The chief irrigation in Victoria, however, depends on water obtained from the Goulburn River which rises in the highlands in the east of the State (Fig. 33). Small supplies are also obtained from the Campaspe and Loddon Rivers. A weir crosses the Goulburn at Nagambie, and a reservoir has been built near its headquarters. By this means water is carried east to augment the lower Broken River and west to the Waranga Basin and to augment the Campaspe and Loddon Rivers. During 1923–1924 the total area irrigated in Victoria was 324,558 acres, of which 94,479 acres were under alfalfa, 96,887 acres for cereals, and 64,647 for gardens.

There are two large irrigated districts thus served. The western area extends for about 50 miles south of Koondrook and includes the towns of Kerang and Cohuna. The eastern district extends for about 50 miles to the southeast of Echuca.

In addition to the land irrigated by these schemes there are large areas in the drier Wimmera and Mallee districts which are supplied for domestic purposes, and stock use, with water carried by long channels from small reservoirs at the head of the Wimmera and other western rivers. No less than 14 million acres were benefited in this fashion in 1923.

It is worthy of note that this environment corresponds fairly well to that served by irrigation in the United States. As there, the annual rainfall is between 10 and 20 inches. Neither country can teach us how to solve the problem of opening up arid Central Australia.

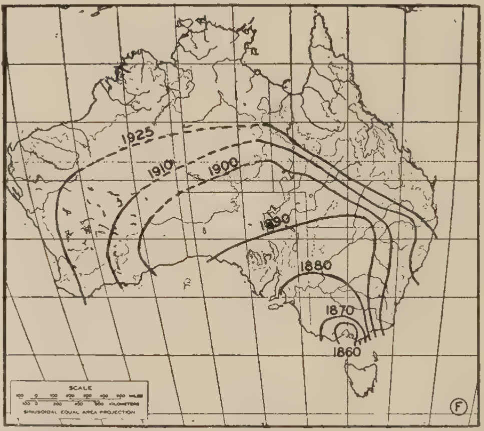

FIGURE 34.—The spread of the rabbit pest over Australia was relatively fast and apparently irresistible. Most of the continent is now infested. Isopleths correspond to wave fronts at dates specified.

DISTRIBUTION OF AGRICULTURAL PESTS

Since the latter part of the eighteenth century Australia has been menaced with agricultural pests.

RABBITS[10]

Some rabbits were carried to Australia in the ships of the "First Fleet," for in 1788 they are recorded at Sydney (Fig. 34). In 1859 twenty-four were brought to Geelong in Victoria and about 1863 a large warren was established near Castlemaine, Victoria. When the fence at the latter site was destroyed by fire, the rabbits escaped and overran the central and western districts of Victoria. About 1880 the first long fence was constructed in the northwest of Victoria, and in 1887 a longer fence against rabbits and wild dogs was built between Victoria and South Australia. But, it was found almost impossible to supervise these fences, and to prevent fires destroying them, and the rabbits soon spread as far west as the Murray River in South Australia.

In South Australia they seem to have spread independently from Adelaide to Peterborough and Renmark by 1881. They reached Beltana by 1886 and Fowler's Bay and Lake Eyre by 1891.

In New South Wales the menace was well developed by about 1883, and in the next five years nearly one million pounds was spent to counteract them. Thus, the rabbits reached Tilpa (near Bourke) in 1882 and Coonamble in 1898. In 1887–1888 a fence was built across the State from Bourke to Corowa, and in 1890 another fence 648 miles long was erected between New South Wales and Queensland. This latter costs £11,000 per year to maintain. Soon, however, the rabbits crossed into Queensland.

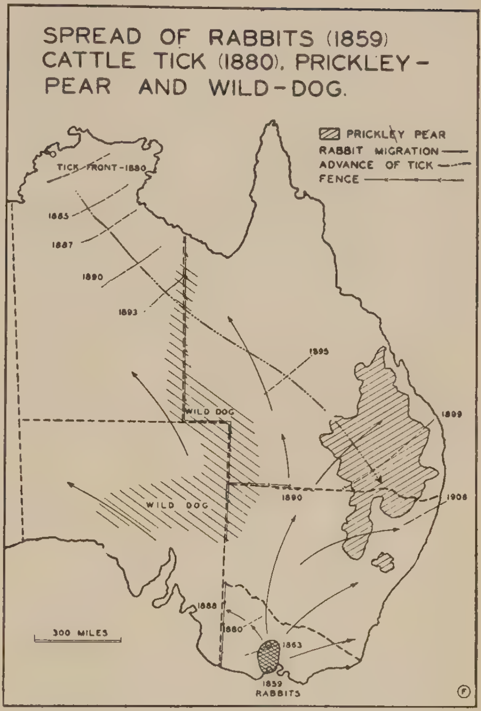

FIGURE 35.—The spread of rabbits introduced in 1859, the cattle tick introduced in 1880, the prickly pear, and the wild dog have materially added to the handicap the Australian settler has had to overcome.

In 1886 they had penetrated 30 miles into South Queensland. In 1895 there were many at Thargomindah, and in 1899 they reached Charleville. In 1906 they were seen near Camooweal. In 1922 they reached Longreach, but they are still largely confined to the south and southwest of Queensland. A tremendous network of fences characterizes Southern Queensland.

West Australia was the last State to become infested, for the wide desert stretch isolates it from the rest of Australia everywhere except in the north. Two great fences were erected. One runs from near Geraldton to Yalgoo and thence south to near Albany. It was built in 1904 and 1905. The larger runs from Condon on the northwest coast to

---

[10] Data were gathered from various State Departments of Stock, to whom the writer's thanks are due. Only in Queensland, however, does information appear to have been systematically recorded.

Hopetown 150 miles east of Albany. This is a distance of over 1,000 miles and was built from 1902 to 1907. Rabbits were first noted at Kalgoorlie in 1901, at Peakhill in 1913, York 1916, and Albany 1918.

The writer recently motored along this fence in the heart of West Australia, and found that it was not of great value, for the rabbits had passed from the desert westward into the huge unfenced "stations" (ranches). Since about ten rabbits eat as much as a sheep, the damage done by the rodents can be imagined. Upon three stations in New South Wales (aggregating one million acres) the carrying capacity between 1880 and 1890 was reduced by 120,000 sheep. But, with poisoning, trapping, digging-out, and closer fencing, the rabbit menace is gradually becoming controlled in the chief pastoral districts of Australia.

WILD DOG

In the last decade or so the pastoralist on the borders of the desert country has been greatly troubled by the dingo and by crosses between the dingo and the larger forms of European dogs. Netted fences similar to those to keep out rabbits (but with larger mesh) have been erected between Queensland and the Territory; between Queensland and New South Wales, and between the northwest of New South Wales and South Australia. For a time the dingo lived on the rabbit, but by degrees drought and dog killed off most of the rabbits in the debatable land, and the dogs moved eastward into New South Wales and Western Queensland. Here they killed the lambs in thousands. It is reported that north of Broken Hill one station lost 22,000 sheep and another 45,000 sheep in one year. A bonus is paid for dingo scalps varying from £1 to £10 per scalp, and this menace is now decreasing. But the result has been a remarkable changing from sheep to cattle in much of the wild-dog area, indicated approximately in the diagram (Fig. 35).

CATTLE TICK

This pest has caused grave losses in Northern Australia, especially during the period from 1894 to 1900, when cattle worth £3½ millions died. Many herds lost 90 per cent of their numbers. It started near Darwin in 1880 and by 1900 it had reached Brisbane, as shown in the diagram. By suitable dipping methods the ticks are eradicated, and so the "Texas Fever" (due to protozoan parasites transmitted by the tick) did not spread far south of the Queensland border. It is now, also, well under control in Queensland. From Darwin tick fever spread down the western cattle lands as far as Perth, but it has not caused such serious damage in that part of Australia as in Queensland.

PRICKLY PEAR PEST

This is a growing menace in much of the best agricultural land of South Queensland. Over 30 million acres have been invaded (according to Professor Johnston), and it is increasing at the rate of 800,000 acres a year. Very promising experiments with insects, which prey upon the pear, have been carried out, but the problem cannot be described as satisfactorily solved.

STUDIES OF SPECIAL CROPS

The distribution of the various crops in the six states has now been considered in some detail. It is use-

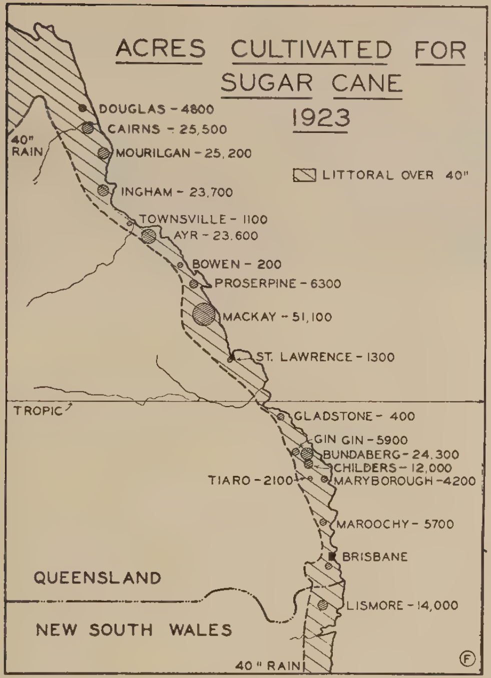
ACRES CULTIVATED FOR SUGAR CANE
1923
DOUGLAS - 4800
CAIRNS - 25,500
40" RAIN
MOURILGAN - 25,200
LITTORAL OVER 40"
INGHAM - 23,700
TOWNSVILLE - 1100
AYR - 23,600
BOWEN - 200
PROSERPINE - 6300
MACKAY - 51,100
ST. LAWRENCE - 1300
TROPIC
GLADSTONE - 400
GIN GIN - 5900
BUNDABERG - 24,300
CHILDERS - 12,000
TIARO - 2100
MARYBOROUGH - 4200
MAROOCHY - 5700
BRISBANE
QUEENSLAND
LISMORE - 14,000
NEW SOUTH WALES
40" RAIN
©

FIGURE 36.—The cultivation of sugar cane has become one of the profitable and promising industries of the tropical and subtropical east coast, where the rainfall exceeds 40 inches annually.

ful, however, to discuss the more interesting crops without reference to State boundaries. As regards importance wheat stands out, and it is treated most fully. Oats is only of considerable importance in Victoria and Tasmania. Its distribution is shown in Figures 18 and 19. Barley is important in South Australia and is charted approximately in Figure 20. A special map of maize (Fig. 40) with a description of the most suitable climate controls is given in the following section. It is surprising that the rich "black soils" of the western slopes of New South Wales are not more fully used for maize. The writer is told that the rainfall is too unreliable—and the soil "too sticky to work." No doubt the future will see these disabilities overcome.

Of the remaining less important crops, sugar is discussed because it illustrates tropical work by folk of British race. Cotton, again, is a newcomer, at any rate, on a large scale. The world is curious to see if it can be grown against outside competition. Finally, Tasmanian agriculture is rather different from that on the mainland—and the environment closely resembles that of north France or south England. It is briefly described. A short discussion of the pastoral industry closes this section.

SUGAR REGIONS

The crop is confined to the well-watered east coast. The sugar is all derived from cane, apart from a little sugar-beet grown in Victoria (Maffra) (Fig. 36). The cane plantations extend down the East Queensland coast and just into New South Wales. The range of average annual temperature is very considerable, from 78° F. at Port Douglas to 68° F. at Grafton. The necessity for a rainfall exceeding 40 inches confines the plantations to the coast. The table on the following page shows the climatic controls.

In Queensland, sugar cane comprises one quarter of the agriculture of the State (about the same as maize) and is worth more than six millions sterling annually. There are 38 mills, the tendency being to shut down the small mills and build fewer but much larger mills.

The plantations are confined to the narrow belt between the highlands and the sea. Here are the constant trade winds, and numerous coastal cyclones give an abundance of rain. The most progressive region is that near Mourilyan, which has the highest annual rainfall in Australia (Harvey Creek, 165 inches). The plan-

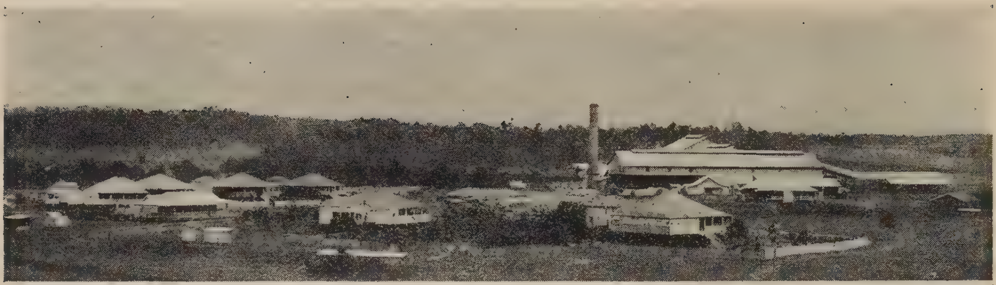

FIGURE 37.—A typical central sugar mill near South Johnstone in North Queensland. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

tations are made in two types of country, the vine scrubs and the eucalypt forest. The former is a true Malayan tropical forest with many softwoods; the latter the more open type without vines, and containing much "bloodwood" (Eucalyptus sp.).

Latitude (° S.)		*Locality*	*Approximate Temperature* (° F.)	*Annual Rainfall* (Inches)	*Cultivated 1923* (Acres)	*Order of Importance*
16		Douglas	78	83	30,300	4
17		Cairns	76	90		
17½		Mourilyan	76	159	48,900	2
18½		Ingham	76	80		
19		Townsville	76	50	24,700	5
19½		Ayr	75	45		
20½		Proserpine	75	42	6,300	7
21		Mackay	72	68	51,100	1
22		St. Lawrence	72	43	1,300	10
24		Gladstone	71	41	400	11
25		Bundaberg	70	41	48,500	3
26½		Maroochy	69	65	5,700	8
27½		Logan	69	32	1,300	9
29	(New South Wales)	Lismore	68	70	14,000	6
	(New South Wales)	Maclean	68	47		

It is stated that the northern canes yield more sugar than the southern. Thus, in the Cairns district 8 tons of cane give 1 ton of sugar, while in the extreme south 10 tons are required. Intermediate regions vary correspondingly.

The industry is of great interest, as the white cane growers near Cairns are the advance guard of such agriculture in the tropics. For instance, the coastlands of Texas have a mean temperature like that of Bundaberg (70°), while Rio de Janeiro resembles Ayr, Queensland. I know of no white farmers outside Queensland who work in latitude 16° at sea level with temperatures such as occur at Port Douglas (see table).

Cane cutting is done chiefly in June and the following cooler months. It is stated that the death rate is low, even among children. This district is fortunate in having the Atherton tableland, 2,000 to 5,000 feet above the sea, immediately behind it, in which the coastal settlers should be able to recuperate. The rainfall is sufficient in most of the plantations, except in the Bundaberg and Ayr districts, where irrigation is resorted to.

Frost occasionally damages crops as far north as Bundaberg, while hurricanes have at times destroyed much cane in Mackay and Innisfall (as in 1918). H. T. Easterby gives a description of the various regions in a recent publication (Brisbane, 1924), from which the following notes are taken.

> "Around Douglas the soil is nearly all alluvial, and both eucalyptus and tropical forests give place to sugar. In the Cairns district the sugar lands occur chiefly in the raised coastal plain along the lower Russell and lower Mulgrave Rivers. There are also large areas of volcanic soil. Similar lands are found near Innisfall. Here the average relative humidity (80 per cent) is probably the highest in Australia (as is the rainfall); which is good for the cane, but uncomfortable for white folk.
>
> "In the Mackay district there is the greatest number of cane-farmers, and almost all the best land is ploughed. A long stretch without any sugar-fields of note separates Mackay from Bundaberg. The latter town is well south of the tropics. The cane grows slower, and in times of drought, cutting may be deferred till next season. Ratoon sugar is more commonly grown here than in the north. Maryborough has changed from cane to dairying, and there is only one mill in place of 15. The same transfer has occurred in most of the sugar areas in the south of the State."

In New South Wales the sugar crop is less than one-half per cent of the total crops. It has gradually been driven north by fear of frost and is now confined to the Grafton-Lismore region in the extreme north. Even here, dairying is displacing sugar, so that the crop now is only one-third of what it was in 1895. There are only three mills in the region.

COTTON REGION

Queensland is the only State where cotton is grown in any noteworthy degree. As far as climate is concerned, it is possible to grow cotton almost anywhere north of Sydney where the rainfall exceeds say 25 inches. The homoclime (similar climate) of the great American cotton area runs along the east coast of Australia from Sydney to Brisbane, but no cotton of note is grown here yet. The homoclime of Berar (the great Indian region) extends around the north coast from Townsville to Derby (West Australia). But this coast has a marked winter drought, and here again no commercial cotton has as yet been grown. In the intervening region from Brisbane to Rockhampton a relatively large area has recently been planted—and will no doubt expand greatly.

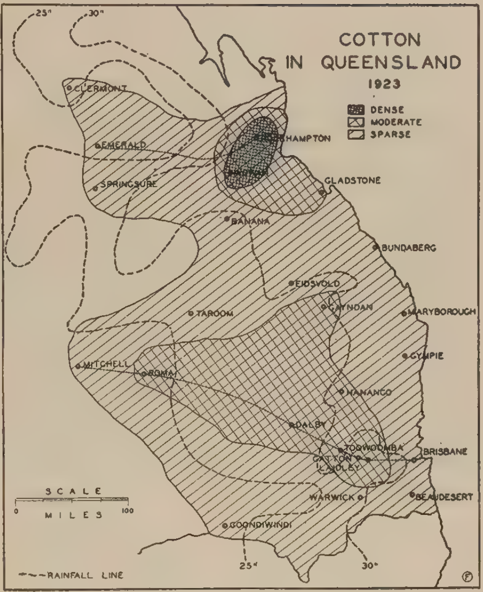

FIGURE 38.—The cotton production of Queensland, though not yet appreciably significant in the world's markets, will possibly expand until it becomes a real factor in the world supply.

Year	*Area in Acres*	*Yield in Pounds*
1919	72	27,470
1921	1,944	940,126
1923	40,821	12,543,770
1925	. . . .	24,000,000

The map of the distribution of cotton in 1923 (see Fig. 38) is in no sense a complete one. The cultivated areas are scattered at considerable intervals. However, it is possible to see where the various agricultural centers are going in most extensively for cotton. It is clear that the Rockhampton region is the chief, for near this town there are

FIGURE 39.—Cotton may be successfully produced on a limited scale as demonstrated at Wowan, near Rockhampton. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

14,000 acres under cotton, and nearby at Wowan 90,000. We may consider this region as the chief center of cotton.

The second isopleth (denoting moderate interest in cotton) also includes Gladstone in the north. But there is a larger area of about this standard along the southern railway from near Toowoomba to Roma. Thus, of equal importance with Gladstone are the Darling Downs (near Toowoomba), Roma, and Gayndah to the north.

The outer limit of cotton gives us the third isopleth. It extends from Rockhampton to Clermont, thence to Mitchell and so south to the border at Goondiwindi. Within this boundary in 1923 were about 75,000 acres, of which about 41,000 were bearing, and 34,000 not bearing. Only 400 acres were to be found in the rest of Queensland.

It is clear that the cotton is grown in regions a good deal drier than those used in the chief centers of the world's supply (*e.g.* United States or India). It is difficult to imagine that such dry places as Emerald, Springsure, and Goondiwindi can rival the better lands near the coast. The latter are largely devoted to sugar, but probably in the future cotton will move toward the wetter regions and perhaps displace sugar to some extent. Uruguay, South China, and Natal are homoclimes of this agricultural region. As shown in the section on sugar, the average temperature at Rockhampton is about 72° F., and at Brisbane about 69° F. The inland towns, Wowan and Toowoomba, are elevated about 1,500 feet, and are correspondingly cooler.

MAIZE

Although maize is one of the most important cereal crops in the world, it does not bulk largely in Australia, constituting only 2 per cent of the total agricultural produce. This is the more surprising, because much of southeast Australia is a homoclime of the "corn-belt" of the United States. However, it is confined almost entirely to the two States of New South Wales and Queensland (see Fig. 40).

In 1923 and 1924 the maize data were as follows:

	1923–1924	*1924–1925*
New South Wales		
Acres	166,933	146,564
Bushels	4,621,950	4,208,200
Queensland		
Acres	120,092	229,160
Bushels	2,024,902	7,330,821
Total Australia		
Acres	316,309	398,949
Bushels	8,114,733	12,432,037

Over 90 per cent is grown for the grain, but a good deal serves as green forage in dairies. The total amount has fallen off since 1910–1911. The average yield per acre is about 25 bushels.

Reference to the map shows that the optimum conditions occur to the

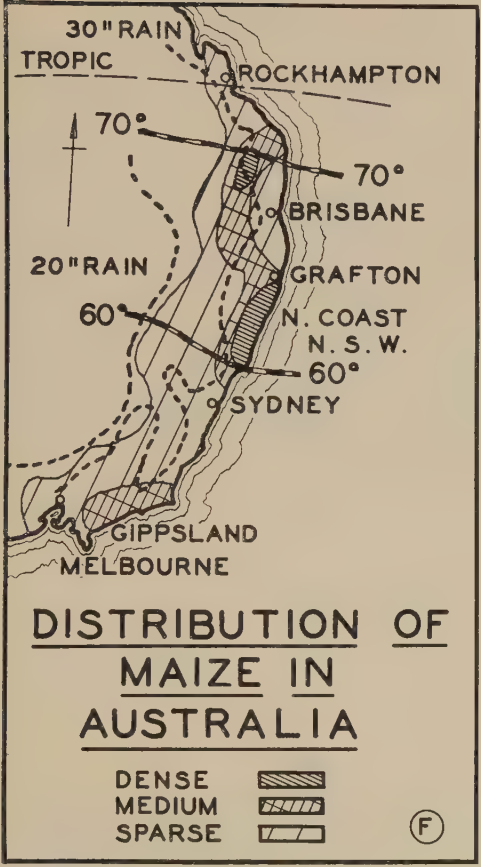

FIGURE 40.—Maize does not bulk large in the agriculture of Australia, constituting only 2 per cent of the total agricultural produce. Optimum conditions for its production pertain northwest and south of Brisbane.

northwest and south of Brisbane. Here the rainfall is from 30 to 35 inches per annum, and the average temperature from 65° F. to 70° F. A much colder locality with some maize occurs in Gippsland, Victoria.

WHEAT [11]

This crop is by far the most important in the Commonwealth and constitutes 63 per cent of the area cultivated. Only in Queensland in 1924–1925 (18 per cent) and Tasmania (5 per cent) has it a subordinate position. The production and climatic controls in the several States are given below.

The primary control is the rainfall, but it is not the total precipitation so much as the amount which falls during the growing period (April to October) which determines the wheat belt (Fig. 41).

The Commonwealth Meteorologist gives the following areas as suitable in climate for wheat, and the author has added the areas actually cultivated in the second column.

State	*Over 10 inches* (Square miles)	*Approximate Area* (Square miles)
New South Wales	163,772	5,000
West Australia	93,500	2,000
Queensland	79,247	230
Victoria	74,616	4,200
South Australia	46,980	3,700
Tasmania	26,215	340
	484,330	15,470

There are obviously vast areas suitable for wheat, which have not been developed. The first column, however, makes no allowance for rugged and barren regions which naturally constitute an important

WHEAT 1923–1924 AND 1924–1925
Period—July to June

	Bushels 1923–1924	*Bushels* 1924–1925	*Temperature—April-October* Whole Region	Optimum Region	*Rainfall—April-October* Whole Region	Optimum Region
New South Wales	33,171,000	59,752,000	61° to 52°	61° to 52°	25° to 9°	15° to 11°
Victoria	37,795,000	47,364,000	55° to 52°	55° to 52°	25° to 8°	15° to 10°
South Australia	34,551,000	30,528,000	58° to 54°	57° to 55°	25° to 6°	20° to 10°
West Australia	18,920,000	23,887,000	63° to 57°	62° to 57°	30° to 10°	20° to 15°
Queensland	243,000	2,779,000	62° to 60°	....	20° to 10°	....
Tasmania	305,000	231,000	52° to 46°	....	40° to 10°	20° to 15°
	124,985,000	164,541,000				

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[11] This account is based on a paper read before the Royal Meteorological Society of London in 1920.

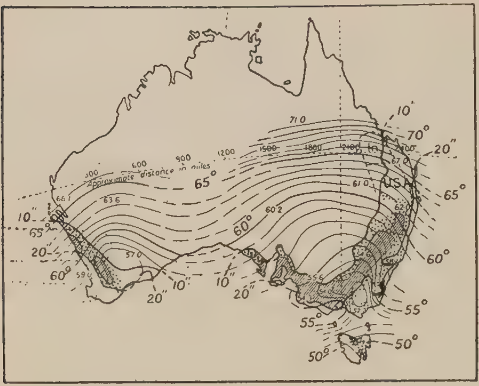

FIGURE 41.—The climatic control of wheat production. (The 10-inch and 20-inch winter rainfall [April–October] is based on H. A. Hunt.) The average temperature during the same period is given. Regions of heavy wheat production are ruled; of light production are dotted. Analogues with Indian and U. S. A. wheat fields are indicated in Queensland. (From the author's "Australian Meteorology.")

portion of our wetter littoral, since this includes almost all the highlands.

In the early stages of wheat-growing in Australia mistakes were made and progress was slow. Cultivation was confined to the moist coastal country with its annual rainfall of 30 to 40 inches, and wheat was not a success (see Fig. 17). The discovery that the drier districts inland were more suitable for wheat growing altered the position very greatly. The bulk of the wheat is now grown in districts with a rainfall of 25 inches and under. On well-worked fallowed land it is stated that splendid crops have been gathered, although the growing crop only had two or three inches of rain.[12]

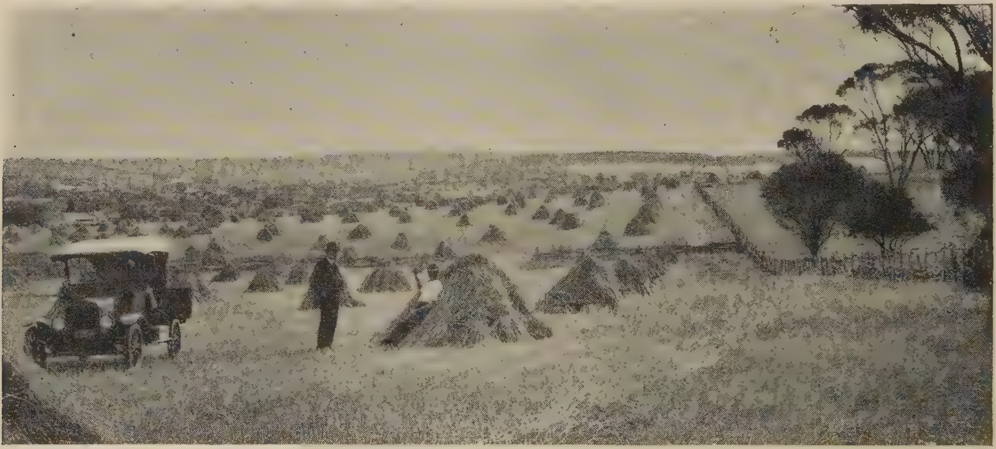

FIGURE 42.—Wheat in shock on Roe's Farm, Northam, West Australia, in one of the richest wheat belts in the Commonwealth. (Courtesy of West Australian Govt.)

In Australian wheat districts the quantity of rain is not as important as the time of the year in which it falls. Rain is wanted in the early autumn so that ploughing can be done, and in the spring when the wheat is heading and flowering. With rain in April and May, and again in September or October, the Australian is assured of a fine crop. The summer is usually dry and warm, and this is one of the main advantages. Unless the common rule is broken and the season is unduly wet, there is no fear of rust, and nothing to interfere with the hay-making. The main crop, which is kept for grain, can be left standing safely in the paddocks until it is thoroughly ripe, when it is taken off with a stripper or

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[12] "Wheat-growing in Australia," Melbourne, 1915.

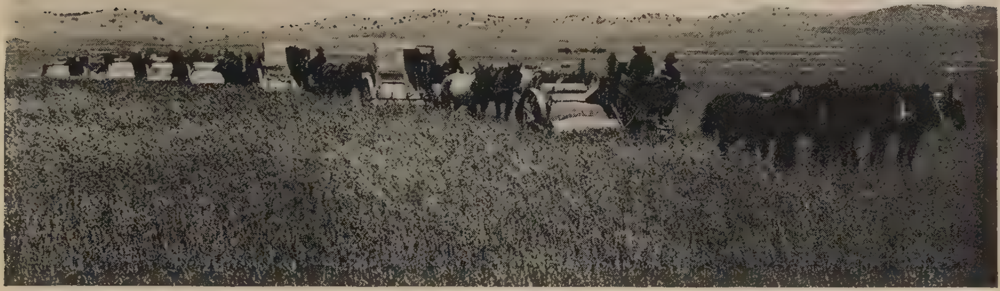

FIGURE 43.—Harvesting wheat on a grand scale at Hallett in the midnorthern agricultural area, South Australia. (Courtesy of South Australian Govt., Intelligence and Tourist Bureau.)

harvester and bagged. Thus, the districts that have the heavy summer rain are largely unsuitable for wheat-growing.

If reference be made to the rain reliability map (Fig. 3), it will be seen that conditions in this respect are best in Swanland (West Australia), and worst in the north of New South Wales. The former has the rainfall in winter, the best season, and though the total is low, it is reliable. The latter has most of the rain in summer, and it is also distinctly unreliable.

In most of the wheat areas the crop depends very largely on the rainfall stored in the soil from the previous year. The actual rainfall during growth may be only 7 inches or even less, but this is supplemented by the fall while the land was fallow.

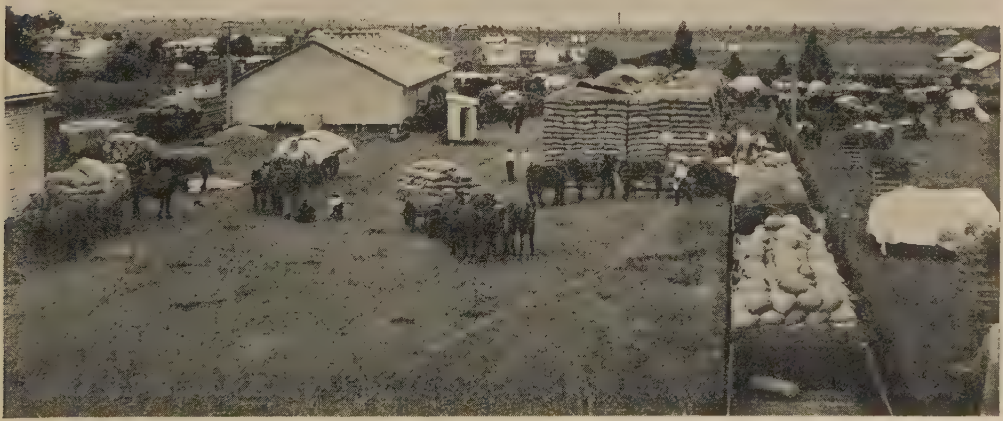

FIGURE 44.—Wheat arriving for shipment in the railway yards in Laidley, southeast Queensland. A steady procession of farmers' wagons converges upon the town at the height of the harvest season. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

In New South Wales the practice is

to plough the land in July or August, to a depth of from 4½ to 5 inches, and then to let it lie for six weeks, after which it is harrowed. Subsequently the fallow receives frequent workings with the cultivator, so as to form a loose mulch which checks evaporation. This operation is repeated (until sowing time in April or May) whenever a hard crust is formed. The majority of districts enjoy an annual rainfall of 20 inches or less, and it not infrequently happens that only from 6 to 8 inches of this falls during the growing period, which is quite adequate to produce a crop of wheat of, say, 20 bushels.

In New South Wales the most productive region is the Riverina around Corowa, and thence north to Molong. The county of Hume as a whole produces 1,800 bushels per square mile, and is probably the most productive center for Australia. The relation between the wheat isopleths and the winter isopleths is extremely close. The 10-inch line is the western boundary of the wheat area except at one or two places. A rainfall of over 20 inches in the wheat period practically fixes the eastern boundary in this State, for only around Sydney is a little wheat grown in wetter districts. But, until the railways are much more numerous, there will be large areas of wheat-land unoccupied. The farthest distance from the railway to make wheat-growing profitable should not exceed 18 or 20 miles (see Fig. 17).

A revolution in wheat growing may be said to have taken place with the advent of "Federation" wheat and other new varieties produced by William Farrer. Such an extensive range is provided that farmers can now begin their sowing in the principal areas with one kind of wheat at the end of March, continue sowing through April, May, June, and finish with certain varieties at the end of July.[13] The early sown varieties ripen later, and so the harvest ripens in stages and can be more readily handled.

In Victoria the greatest area under cultivation lies in the north and northwest (see Fig. 18). The irrigation counties of Rodney and Moira are the most important (though the wheat is not often irrigated), but the adjoining Wimmera regions are nearly as important. These regions fall within the rainfall controls specified earlier. There are several outlying regions of considerable interest in Victoria. Thus, around Sale is a small wheat district in the wet region of Gippsland, due to the low rainfall of a rain-shadow. In the same way the rain-shadow to the southwest of Melbourne includes the drier coastal counties which grow wheat. In the Victorian Mallee is a large extent of sandy loam country with a light winter rainfall from 10 to 15 inches. For a long period this land was deemed unfit for wheat, but experience has proved that it is quite profitable when properly worked. The land is, of course, worked on the three-year rotation system of fallow, wheat, grazing.

In South Australia there is a northward bulge in the isohyets caused by the Flinders Range and possibly influenced also by the long gulfs running 200 miles into the continent. Here six counties around St. Vincent Gulf each produced more than two million bushels for the season 1915–1916. The climate is ideal for wheat culture, nearly all the rain falling in winter. Hence, the production per

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[13] Vide Ross "Wheat" in Handbook for New South Wales.

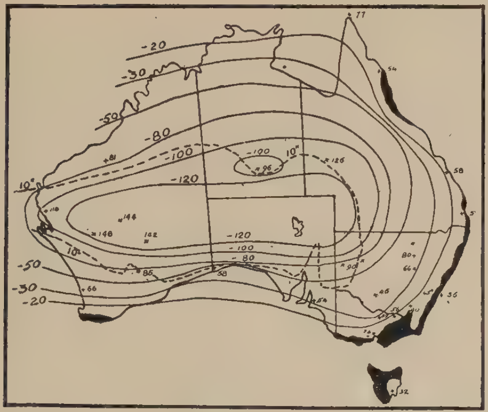

Figure 45.—Sketch map showing net rainfall (rainfall − evaporation). Small figures are inches evaporated per annum. Black areas are those where rainfall exceeds evaporation. (From the *London Meteorological Journal*, 1920.)

head of population is much greater in this State than any other. The county of Daly (around Wallaroo) produces nearly as much wheat (1,690 bushels) per square mile as Hume in the Riverina. The 6-inch winter rainfall line, which is about equivalent to the 10-inch annual isohyet, seems to mark the outer limit of wheat culture. This is considerably beyond "Goyder's Wheat Line," which was laid down in 1865 as a safe limit and was based on the native vegetation. The West Australian wheat belt is described elsewhere.

Dry Farming and the Limits of the Wheat Belt

It is very difficult to determine the lowest limit of the rainfall which admits of profitable agriculture in Australia. In much of the wheat region only one-third of the area is under wheat at a time; and the dry farming methods of fallowing and careful tilth become increasingly important as the arid interior is approached.

Although the wheat belt lies in a region of winter rainfall (except in the northeast) there is no portion of Australia without an appreciable summer rainfall. Thus, even in the Northam region (West Australia) the five hottest months contribute 3 inches out of the total 17. Hence, the statement that "all the rain falls at the right season" is only relatively correct.

The definition of dry farming varies in the district concerned. Thus, in South Australia a region receiving less than 13 or 14 inches a year is so classed, but in northern New South Wales 22 inches or even 25 inches is "dry." In Victoria wheat is grown in the Mallee country between Ouyen and Pinneroo, with an average of 13 inches of rainfall.

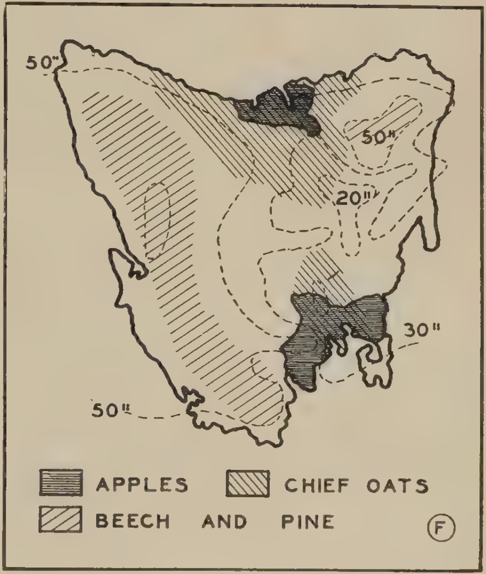

Figure 46.—The cool temperate climate of Tasmania favors the growth of the cereals, root-crops, fruits and vegetables upon which the white race depends for its food supply. Apples, potatoes, hops, and oats are among the leading crops. (From the *London Meteorological Journal*, 1920.)

A factor of vital importance in dry farming is the evaporation. In Australia (as in most parts of the world) only a few stations have records of this element, and some of the records in the west especially are obtained from small pans which are not satisfactory. It has been stated that every 3 inches of evaporation demands 1 inch of extra rain as an offset, so that it is found that 15 inches of rain in the southwest of New South Wales is equivalent to 20 inches in the northwest.[14] The writer gives the net rainfall (rainfall minus evaporation), as nearly as the records will admit, in Figure 45. It is to be noted that a worked summer fallow accumulates 5½ to 7 inches more water (in the upper 6 feet) than similar soil growing a crop.[14]

FIGURE 47.—The prosperous apple orchard districts of Tasmania constitute one of the most attractive landscapes of Australian agriculture. (Courtesy of Tasmanian Govt.)

The typical dry-farming region in South Australia for profitable wheat is the Mallee—of which Lameroo may be taken as a type. But, here 16 inches is the average. The land, however, was locally termed "desert" until about 1896. It consists of light, sandy ridges running east and west, which are about one-fourth mile wide. Dark loamy hollows alternate with the sand-ridges. Mallee scrub (6 to 15 feet high) covers most of the country. This is rolled down in June or July, and then burned. With the aid of superphosphates, crops of 13 bushels are not uncommon, though 8 has been the average to date (see Fig. 10).

The writer in his *Bulletin on Climatic Control*[15] showed that a close parallel existed between the conditions in East-Central Queensland (between Mackay and Charleville) and in Central India. At Jabalpur

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[14] Anderson, Dry Farming Conference, Adelaide, 1911.

[15] Melbourne, Commonwealth Bureau of Meteorology, Bulletin No. 14, 1916.

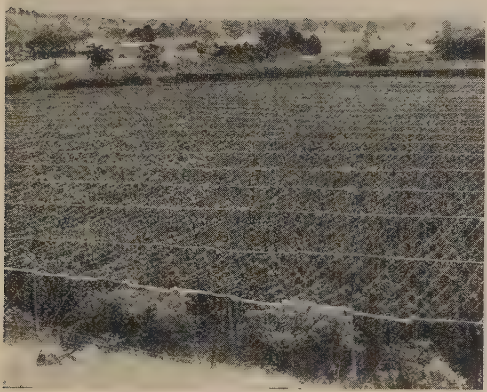

FIGURE 48.—A valuable yield of hops in Tasmania, not far from Hobart. (Courtesy of Tasmanian Govt.)

in India the temperatures are much higher than those of the Queensland wheat belt, yet great quantities of wheat are grown.

TASMANIA—THE COOL TEMPERATE STATE

This elevated island lies 150 miles south of Victoria. Its area is 26,000 square miles, and its average temperature is near 52° F., about the same as that of the south of England. Thus, the climatic controls differ considerably from those of the Mainland. It lies almost permanently under the influence of the moist westerly winds (thus in part resembling southwest England). The high western part of Tasmania is too bleak and wet for settlement—a unique feature in hot arid Australia! A strip of highlands near Mount Lyell receives over 100 inches of rain a year (see Fig. 46). The population is confined almost wholly to the north and east, and there are two economic centers—Launceston and Hobart, the latter being the capital. The northern tract from Wynyard to Launceston is one of the most populous parts of Australia (see Fig. 46).

In spite of Tasmania's small area (less than 1 per cent of the Commonwealth) in such a crop as potatoes it ranks near Victoria, the leading State, while a much larger proportion of the population is engaged in orchards and hops than in any other of the States. Oats is the chief crop, there being, in 1923, 51,000 acres as opposed to 14,000 acres under wheat. The chief centers of production are along the north coast, and in the central north. Potatoes are a very important crop, there being 37,000 acres, chiefly in the northwest from Wynyard to Sheffield. The fruits grown in Tasmania include all those of temperate climes, but apples are by far the most important. The area rivals that of Victoria comprising 25,000 acres. The chief apple center is to the south of Hobart, near Franklin, but a good many are grown around Launceston.

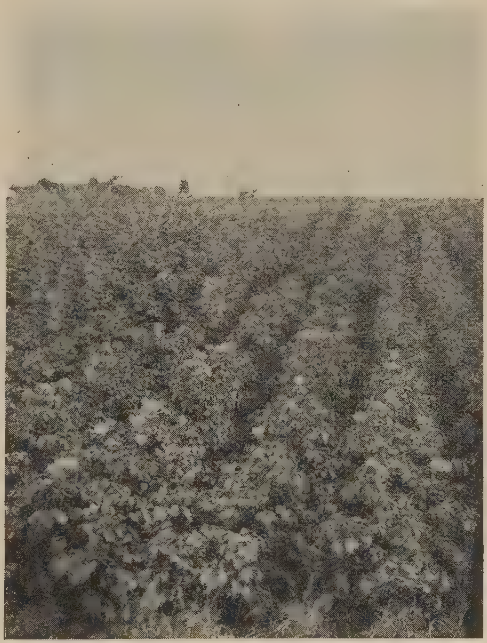

FIGURE 49.—Potatoes in bloom, promising a heavy crop of tubers, on new land from which the original forest has but lately been removed. (Courtesy of Tasmanian Govt.)

Timber is of considerable importance. Owing to the good rainfall the proportion of forest is greater than in any other State—for the whole except the Central Plateau is more or less covered. The trees are chiefly eucalypts in the east; but a different association, due to the very heavy rainfall is found in the west and in the Ben Lomond region in the northeast. Wherever the rain exceeds 50 inches yearly, the eucalypt is largely replaced by an evergreen beech (*Fagus Cunninghami*), and this same tree occurs in a similar habitat on the coast of Victoria. Moreover, there are small but valuable areas of softwood pines in the west. These areas are indicated in Figure 46.

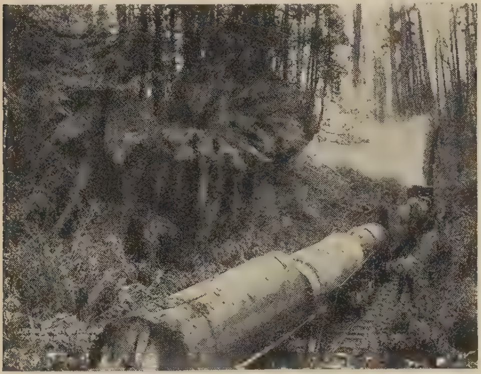

FIGURE 50.—Tasmanian timber operations. Hauling out saw logs by steam donkey engines from the more heavily forested areas. (Courtesy of Tasmanian Govt.)

PASTORAL INDUSTRY IN AUSTRALIA

The brief discussion of the general environment of the continent has shown that Australia as a whole is better suited for pastoral than for agricultural industries. While the agricultural areas will some day expand considerably to the westward especially in Queensland and along the north coast, yet three-quarters of Australia is probably too dry and hot for profitable agriculture. On the other hand, hardly any of it is so dry that some stock may not be grazed upon it. While a very large area (65 per cent) receives less than 15 inches of rainfall a year, only a small proportion (about 7 per cent) receives less than 6 inches.

RAINFALL AREAS IN AUSTRALIA
(After H. A. Hunt)

	Square Miles	*Percentage*
Under 10 inches	1,067,357	36
10 to 15 inches	603,605	20
15 to 20 inches	358,458	12
20 to 30 inches	534,766	18
30 to 40 inches	213,195	7
over 40 inches	194,423	7
Total	2,971,804	100

It is this large proportion of arid Australia with a rainfall over 6 inches, which accounts for the almost total absence of shifting sand-dunes. Very large areas, however, are now covered with fixed dunes, so that apparently central Australia was even drier in the not very remote geological past; though the cycle immediately preceding the present one would seem to have been much wetter than at present.[16]

The stock of Australia grew fairly rapidly in numbers from 1860 to 1890 (see Fig. 51), then diminished rapidly to 1902, since when they have climbed again to much the same figure as in 1890. This is shown clearly in the accompanying graph (from the *Commonwealth Year Book*), where the heavy black lines indicate the years of drought. It was the great drought of 1902 which put an end to the overstocking which had existed about 1890. But rabbits and other pests have also in part accounted for the slow increase since 1890.

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[16] This aspect of the paleogeography of Australia is fully discussed in the writer's recent book "Environment and Race," Oxford, 1927.

The total numbers of stock in the different States are given in the table below.

CATTLE

As regards cattle we can divide the total into dairy cattle and beef cattle. Very different environments determine the range of these two types. The dairy cattle are naturally found where pasture is rich, which confines them practically to the well-watered east coast of Australia, or to the rare irrigation regions. Furthermore, proximity to large towns has until lately been an important factor as regards the dairy industry. This is, however, becoming of less importance as better means of communication and more and more refrigerating plants and butter factories are established (see Fig. 52).

	Number of Cattle	*Per Cent*	*Number of Sheep*	*Per Cent*
New South Wales	2,932,437	22	37,539,413	47
Victoria	1,591,367	12	11,059,761	14
Queensland	6,396,514	48	16,756,101	21
South Australia	413,272	3	6,596,875	8
West Australia	953,764	7	6,595,867	8
Tasmania	220,351	2	1,557,716	2
Northern Territory*	843,718	6	6,914	..
Total	13,351,423	100	80,112,647	100

*Northern Territory was subdivided in 1926 along latitude 20° S. into Northern and Central Australia. The division has little economic significance.

The densest distribution of cattle is perhaps found in Victoria, where the cooler climate and good rainfall are particularly suitable for milk production. The north coast of New South Wales and the adjacent coastline of Queensland (around Brisbane) are equally important dairy regions. These two latter areas are those where the chief maize crop of Australia is grown (see Fig. 53).

The second grade of cattle distribution is found associated with dairies near less important cities with good pasture such as Launceston and Hobart in Tasmania, or near large cities with a dry climate such as Adelaide and Perth.

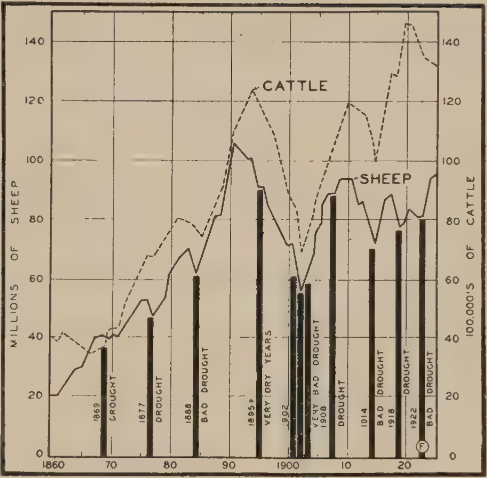

FIGURE 51.—That there is a close relation between the prosperity of the livestock industry and the annual precipitation, this chart leaves no doubt for Australia. Rabbits and other pests have also played a part. (From Commonwealth Year Book.)

The third grade occurs in the Tropics along a belt from Townsville, Queensland, to Broome, West Australia. This is a belt of Savannah or prairie country with a well-marked summer rainfall. It is too dry to grow forests, and indeed forms part of the prairie belt which everywhere fringes the desert belts of the world. To the north the grasses become too rank, and in the opinion of some authorities, they are here less nutritious than similar grasses in drier localities.

Certain halophytes (like saltbush,

Atriplex) are valuable fodder-plants found on the southern edge of this great cattle belt. It comprises the Fitzroy Valley in the west, the Victoria river area and Barkly Tableland in Northern Territory and the Northern "Downs" of Queensland.

The remainder of Australia from the point of view of cattle distribution is divided into two grades. There is a large area in the west where there are no cattle—and indeed only a few sheep on the southern edge. This is mostly so arid, that it has not yet attracted pastoralists. The intervening regions labelled *Sparse* and *Fair* in the adjoining map (Fig. 53) are the chief habitats of sheep. Since the latter pay better than cattle (other things being equal) there is no great area given over to cattle in the drier regions in Australia, south of the Tropic. It is to be noted, however, that in the heart of Australia (in the Macdonnells), and to an increasing degree on the edge of the "Never Never" (as the absolute fringe of settlement is called), cattle and not sheep are usually pastured. This is because they are hardier; they can travel about ten miles to water (as opposed to five miles for sheep), and they can withstand such pests as wild dogs.

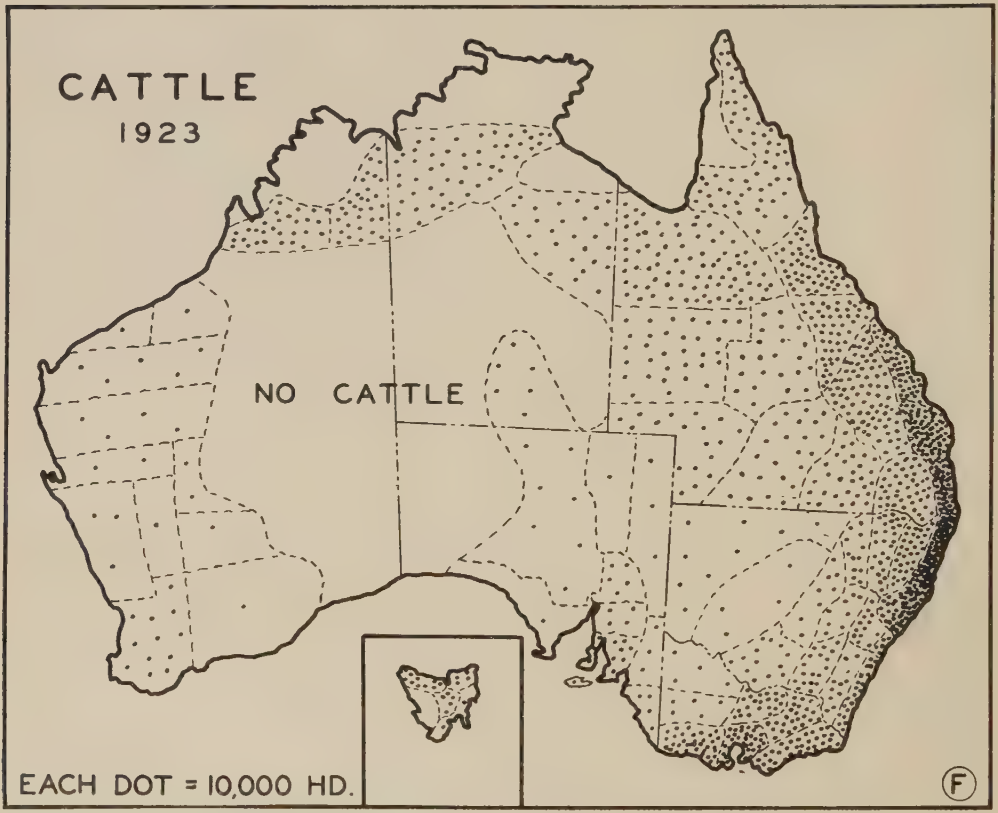

FIGURE 52.—The distribution of the cattle of Australia.

Dairy Farming

Three-quarters of the dairying is carried on in the States of New South Wales and Victoria. Cattle bred for dairy purposes need milder

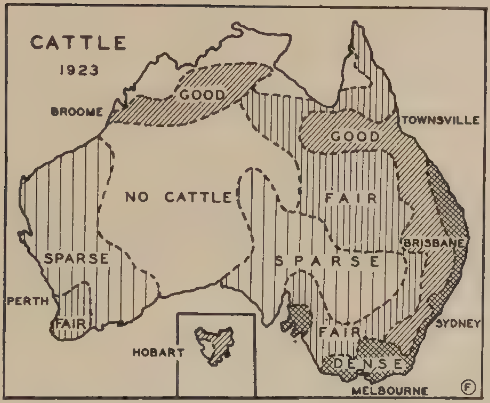

FIGURE 53.—This map of relative importance of the cattle industry in various sections of Australia supplements well the dot map of distribution in Figure 52.

climatic conditions than those reared for beef only, so that the chief dairy regions are along or near the coasts.

In New South Wales the center of the industry has migrated from the south coast to the north coast, where land is cheaper and the rainfall in general heavier than in the original center of dairying in the Illawarra district.

FIGURE 54.—Ayrshire cattle are well adapted to the conditions of the better range country in West Australia. A herd on pasture near Toodyay. (Courtesy of West Australian Govt.)

Along the coast the rainfall is uniform and reliable. Here also the evaporation is less than the rainfall, and hence the vegetation keeps green all the year round. There is, however, a great deal of milk and butter produced at some distance from the coast by farmers who combine dairying with wheat-growing or mutton-raising.

Seventy-five per cent of the milch cows in the State are in the coastal region, and no less than 277,000 (half of the whole number) are found on the north coast. Over one million acres are under sown grasses along the coast, and in the colder southern dairy districts a great deal of ensilage is prepared.

Victoria, however, led the way in dairying, and here it occupies a larger proportion of the State than in New South Wales. For the most part the cows are fed solely on natural pastures, but progressive farmers find it pays them to grow fodder for their herd and to shelter the animals in the winter.

Two-thirds of the dairy cows are kept in the Western District and in Gippsland. The former is famed for its rich volcanic soils and almost every town and hamlet has its butter factory. The rainfall varies from 25

FIGURE 55.—A typical pastoral scene at Newmarracarra, Swanland, West Australia, in a rich grazing and agricultural section. (Courtesy of West Australian Govt.)

to 30 inches. In Gippsland the rainfall is heavier, from 25 to 40 inches, and large areas were covered by heavy forest; but this is giving place to dairy farms, so that practically every railway station has become a center of the industry. Owing to its suitable climate, much maize is grown and much of this crop reaches the market in the form of butter and pork.

Queensland is rapidly progressing as a dairy country, especially the south coast and Darling Downs; while in South Australia the dairies spread from Port Germein (near the head of the Gulf), with a rainfall of only 13 inches, down to Mt. Gambier in the extreme south, with a rainfall of 32 inches.

Sheep

In respect to the number of sheep, Australia leads the world. In 1924 there were over 93 million head, whereas Russia was far below with 67 millions and the United States with 41 millions. It is interesting to note how the number of sheep varies with the general character of the rains (Fig. 56). It is, of course, primarily the rain in the southeast of Australia which affects the sheep industry, since three-quarters of them live in this corner of the continent.

	1923 (In millions)	*1924* (In millions)
New South Wales	37	47
Victoria	11	13
Queensland	17	19
South Australia	7	6
West Australia	7	6
Tasmania	1½	1½

Since New South Wales contains nearly half of the total number, we may consider their distribution here in a little more detail. The State may well be divided into four belts parallel to the coastline. In the East are the rather wet rugged coastlands which contain only a few per cent of the whole. The sheep are largely Romney Marsh and are grown chiefly for mutton. About one quarter of the sheep pasture on the Highlands, and consist chiefly of Lincoln, Leicester, or cross-bred sheep (chiefly with merino). These give heavier carcasses and coarser wool than the pure merino. The next belt constitutes the western slopes and the Riverina, 60 per cent of the sheep grazing here. They are largely hardy merinoes, which thrive in spite of the relatively dry climate and produce fine staples which are readily purchased by wool buyers from all over the world (see Fig. 9).

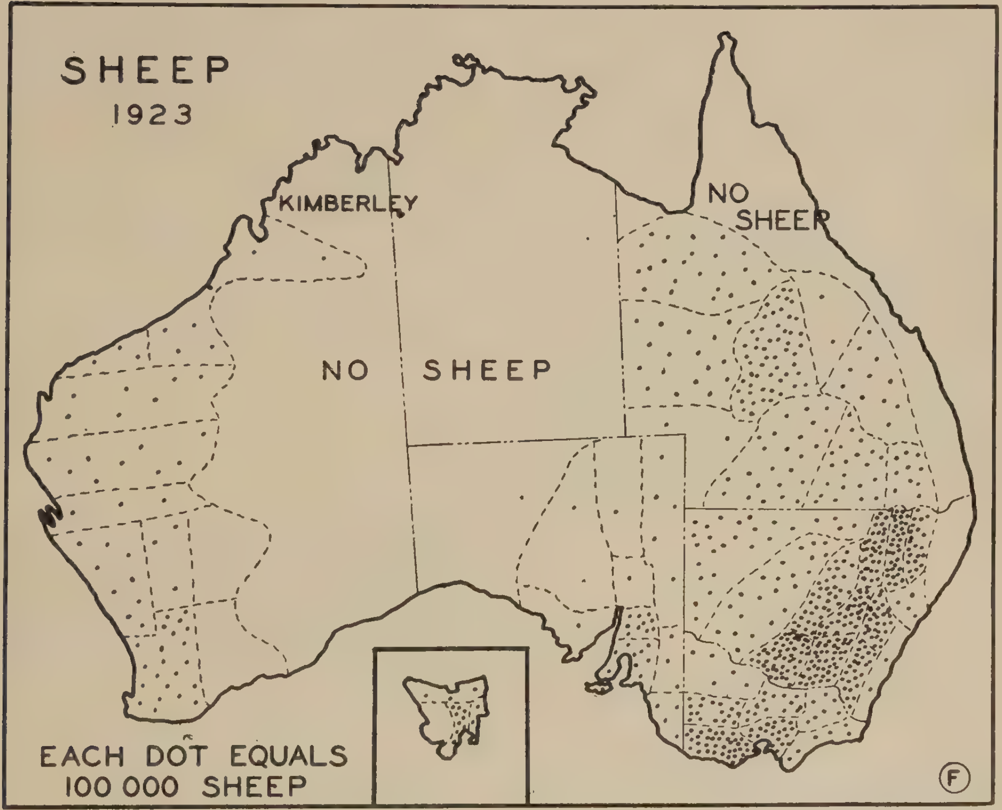

FIGURE 56.—The concentration of sheep to rather more restricted area than cattle occupy, as well as their distribution, is well revealed in this chart.

The northern limit in Australia seems to be defined partly by temperature and partly by the character of the resulting vegetation. Rank, spiny grasses are unsuited for sheep, and few are pastured where the temperatures exceed 75 degrees on an average. But as the ranker grasses are burnt out or eaten out by cattle, they tend to become more suited for sheep, so that we cannot yet be sure of their northern limit. At present, the sheep in the Kimberleys (West Australia) withstand an average temperature of about 82° (Fig. 57).

The following table shows the control exercised by rainfall.

RAIN CONTROL

	Optimum (Inches)	*Total* (Inches)	*Chief Districts*
New South Wales	20–30	10–40	New England, Moree, Young, and Riverina.
Queensland	15–20	10–30	Longreach, Darling Downs, Cunnamulla, Clermont.
Victoria	20–30	10–50	Hamilton, Ballarat.
South Australia	20–30	5–30	Mt. Gambier, Adelaide.
West Australia	20–30	8–40	Swanland, Carnarvon, Fitzroy River.
Tasmania	20–30	20–60	Longford, Oatlands.

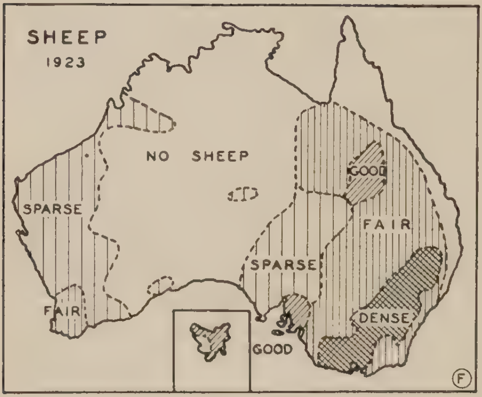

FIGURE 57.—The relative importance of the sheep industry throughout Australia is clearly indicated by this map.

The great drought[17] culminating in 1902 (when the sheep country in southern New South Wales received 9 inches instead of the normal 17 inches) resulted in a decrease of the total number from 95 millions to 55 millions. With each succeeding drought it is probable that these losses will be greatly minimized. Thus, around 1914 another series of bad seasons reduced them from 93 millions to 69 millions. As more railways are built, it will be possible to move the sheep to coastal regions where feed is usually available, and the tremendous losses of the past will not recur.

The close relation between the distribution of sheep and of rainfall is brought out by the following table,[18] which represents the conditions on an east to west section across New South Wales in a somewhat generalized fashion. It is to be noted that the densities are not for fully stocked country, but include the whole area of each of the counties involved in the census.

Annual Rainfall in Inches	*Sheep per Square mile*	*Representative District*	
8	20*	Milparinka	Wholly sheep
10	70	Wilcannia	
15	100	Hillston	
20	180	Forbes	Farming country
25	250	Young	
30	350	Tamworth	
35	400	Armidale	
40	100	Goulburn	
45	None	Few on South Coast	Dairy country
50	None	Too wet	

* Estimated.

DROUGHT

In more than one-third of Australia drought is a permanent condition, while exactly one-half of Australia receives practically no rain for six months of the year. It is, however, the borderlands between these arid regions and the well-watered districts where King Drought is most feared. For here grows our main wheat crop, and here are situated our chief stock regions.

FIGURE 58.—A flock of pure-bred border Leicester sheep at Temora, New South Wales. (Courtesy of New South Wales Govt.)

As regards the inland portion of South Australia, Victoria, and New South Wales, very dry conditions or true droughts have occurred about once every three years. Quayle cites the following (since 1880)—1881, 1884, 1885, 1888, 1895, 1896, 1897, 1899, 1902, 1907, and 1911. We may add the disastrous years of 1914, 1919, and 1923. Of these 1885 was bad only in South Australia, and 1911 had good rains in the least useful season (summer), while 1919 was worst in the Darling Basin.

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[17] *The Climate and Weather of Australia.* By H. A. Hunt, Griffith Taylor, and E. T. Quayle. Melbourne, 1913.

[18] Table based on Figure 14 in the writer's Bulletin, "Climate and Production," 1916.

ARID PASTORAL COUNTRY

While it is true that a very great proportion of the stock is grazed in the wetter regions, yet considerable progress has been made in part of the really arid region. One of the most prosperous of the "desert" pastoral properties is situated 40 miles west of Broken Hill, and conditions here will indicate how much can be done with capital and initiative.

At Mutooroo the average annual rainfall is only 7½ inches, and the rain falls in almost any month of the year; while the evaporation is 90 inches. The "run" covers 3,000 square miles, and was originally waterless, *i.e.* containing no rivers, artesian or shallow supplies, except four small wells. It is an open saltbush (*Atriplex*) plain with a proportion of "scrub."

It now carries 33 sheep to the square mile, and this has been rendered possible by the excavation of 200 "tanks" costing over £100,000. Some of these tanks are huge excavations 100 yards long, 80 yards wide, and 25 feet deep. They collect surface water after the infrequent rains, which is then pumped to the 600 paddocks into which the run is subdivided. It is obvious that many years of effort and an enormous outlay are necessary before such country can be profitably exploited. But the huge unoccupied areas in the south with similar climatic conditions make the lesson an invaluable one. It is to be noted that in the northern arid regions a very much higher rainfall (about 14 inches) would seem to be necessary to obtain equivalent results, owing to the occurrence of a much greater evaporation and also of a long winter-drought season.

SUMMARY OF AGRICULTURAL REGIONS

In recent geographical studies (*e.g.* that of Europe by Jonasson) it has been found useful to use a combined form of map based both on the natural vegetation, and on the uses to which the land is put by man. Since so small an area of Australia is under cultivation (16 million acres out of 1,900 million acres), it is obvious that the areas devoted to individual crops are too small to show on the map of the continent.

FIGURE 59.—Merino sheep constitute one of the most dependable sources of income. A flock near Burrawong Station in the Riverina district of southern New South Wales. (Courtesy of New South Wales Govt.)

In the map those regions where crops have been grown are outside the heavy line. The remainder is either pasture or desert, or a combination of both. In the map a sort of duplex nomenclature is used which emphasizes the fact that it is almost impossible in most regions to define them as belonging to one type. Each type grades imperceptibly into the next and in general the dominant type in the region is mentioned first and the subordinate type is suffixed to the name.

Since Australia is a continent with an unusually large proportion of hot arid lands (65 per cent receiving less than 20 inches of rain, while Africa has only 54 per cent), it is obvious that certain regions will differ considerably from those found for instance in Jonasson's map of Europe. The types which the writer has adopted are given in the following table, where their position in the seven main divisions of the Commonwealth is also indicated. The order given is approximately that of their value as producers.

Even in the densest agricultural region of Australia there are still large areas of the original vegetation, so that the character of the latter may well be summarized before the distribution of the crops is entered upon.

1 AND 4. CROP-PASTURE AND PASTURE-CROP REGIONS IN SOUTHEAST

This consists of a region with an annual rainfall between 12 and 20 inches, mostly falling in winter. The vegetation is formed of savannah forest or Mallee for the most part. Thus, in South Australia and Victoria large areas are covered by a dwarf eucalyptus (Mallee) which grows with clustering stems, and is often removed for crops by rolling it down. On the wetter side are thin forests of various eucalyptus (such as Ironbarks and Boxes) and Pines (*Callitris*) with many smaller Acacias, Grevillias, and Eremophilas. Much grass and in the drier parts Saltbush (*Atriplex*) cover the ground; so that sheep almost invariably form part of the wheat farmer's assets. Crops are more abundant in the south, sheep in the north of this belt.

Agriculture	*Victoria*	*New South Wales*	*Queensland*	*South Australia*	*West Australia*	*Tasmania*	*Northern Territory*
1. Crop-Pasture	North	South	....	South	....	....	....
2. Crop-Forest	South	East	....	....	....	....	....
3. Forest-Crop	Northeast	East	East	....	Southwest	....	....
4. Pasture-Crop	Southwest	North Center	Southeast	Southeast	....	Center	....
5. Forest	East	Southeast	....	....	Southwest	West	....
Pasture							
6. Pasture-Bush	....	....	Center	....	Northeast	....	North
7. Pasture	....	West	Southwest	....	Northeast	....	North
8. Bush-Pasture	....	....	North	....	North	....	North
9. Desert-Pasture	....	....	....	Center	Center	....	South
Desert	....	....	....	Northwest	Center	....	South

AGRICULTURE

FIGURE 60.—Cocoanut palms near Port Douglas on the east coast of North Queensland. These palms are not at all common. (Courtesy of Dept. Agric. and Stock, Govt. of Queensland.)

The crop-pasture region contains almost all the wheat-lands of the southeast, and thus by far the most important portion of the cultivated lands. In New South Wales this involved (in 1923) wheat (worth £6 millions), and most of the hay (worth £9 millions). In Victoria wheat (in 1924) was worth nearly £12 millions, and hay £4 millions, while oats was nearly £1 million. In South Australia wheat produced £7 millions, hay £2 millions, barley and oats £1 million, and vineyards £1 million.

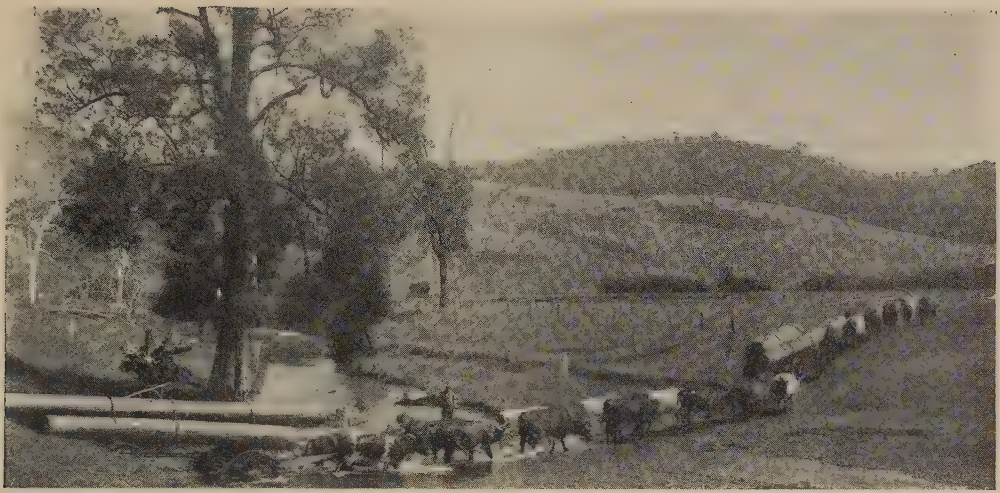


Figure 61.—Hauling timber to the mill near Lamington in the Beaudesert district of the highlands of southeastern Queensland. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

All the agriculture in this last State is included in regions 1 and 4. In Queensland wheat accounts for £1 million; and in Tasmania potatoes and apples each are worth nearly £1 million, and hay £½ million.

STOCK

In the small regions in the east are found nearly half the sheep of Australia, *i.e.*, somewhere about 34 million head. Cattle are much less important, though there are about 2 million head.

1. Crop-Pasture—The Great Wheat-Sheep Belt

C. P. 1. *Wimmera-Riverina*—Chief wheat and irrigation region in Australia. Cattle and sheep more important in southern half.

C. P. 2. *Adelaide District*—Intense wheat, some vines and barley. Cattle and sheep important throughout.

C. P. 3. *Mallee*—Sparse wheat, some cattle and sheep.

C. P. 4. *Eyre's Peninsula*—Sparse wheat, cattle and sheep. (Much saline country.)

C. P. 5. *East Swanland*—Originally rather open forest. Now important wheat, some sheep and cattle.

C. P. 6. *Southeast Swanland.*—Like East Swanland, but poor soils and no wheat. Few sheep and cattle.

4. Pasture-Crop—Great Sheep Region, Wheat Subordinate

P. C. 1. *Great Valley of Victoria*—Dense sheep and cattle. Wheat sparse, oats more important.

P. C. 2. *Western Slopes* (*New South Wales*)—Very important sheep. Wheat good, cattle less important.

P. C. 3. *Darling Downs*—Chief wheat of Queensland. Some maize and lucerne, good cattle and sheep.

P. C. 4. *Maranoa*—Good cattle and sheep, sparse wheat and little cotton.

P. C. 5. *Northern Plains* (*New South Wales*)—Good sheep, sparse wheat and cattle.

2 and 3. Crop-Forest and Forest-Crop

These regions contain notable forest timbers, and are, of course, confined to the areas with fairly uniform rain, which exist only along the east and southwest coasts. The natural vegetation, beginning in the far south, consists of thick "brushes" of beech (*Fagus*) and Acacia, but these are giving way to dairy farms. There are large areas of hill country covered with Eucalyptus, of which one species (*E. Regnans*) is stated to reach 300 feet or more. *E. Obliqua* and *E. Amygdalina* are common in Victoria, while other eucalypti such as Iron-bark, mahogany, and Red Gum are also common trees. On the north coast of New South Wales are thick "brushes" of tropical types such as *Cedrela*, *Flindersia*, and *Doryphora*. These extend along the coast up to North Queensland, together with *Dysoxylon*, *Castanospermum*, and *Araucaria*. The "brushes" are laced together by lianas, and are very different from the open "parkland" forests of most of Eastern Australia. Where the rainfall in the southwest corner of the continent exceeds 25 inches, a valuable forest of Eucalyptus is found. A valuable export industry has grown up, the chief trees being Jarrah and Karri. The country is slowly being converted into dairy farms and orchards, but their total value is not large yet, for settlement is still very sparse. In the two regions, East Swanland and Maranoa, the sheep number about 8 millions and the cattle about 850,000.

AGRICULTURE

These regions are too wet for wheat, but contain the chief dairy farms of Australia. Here also is the sole tropical agriculture in Australia. Thus, Queensland (in 1923) produced sugar cane worth £6 million, maize and forage each worth nearly £1 million, and lucerne and bananas each £½ million. In New South Wales maize was worth £1 million, green forage and fruit each £¾ million, and oranges about £½ million. In Victoria there is not so much wheat, but dairy-farming is general in this southeast portion. However, much consists of rugged untouched forest.

STOCK

There are about 8 million sheep in the inner drier portions of these areas, and about 5 million cattle in the agricultural regions under consideration.

2. CROP-FOREST—DAIRYING BELT

(Dense cattle throughout)

C. F. 1. *Brisbane and Lismore District*—Maize, oats, lucerne, sugar, and bananas.

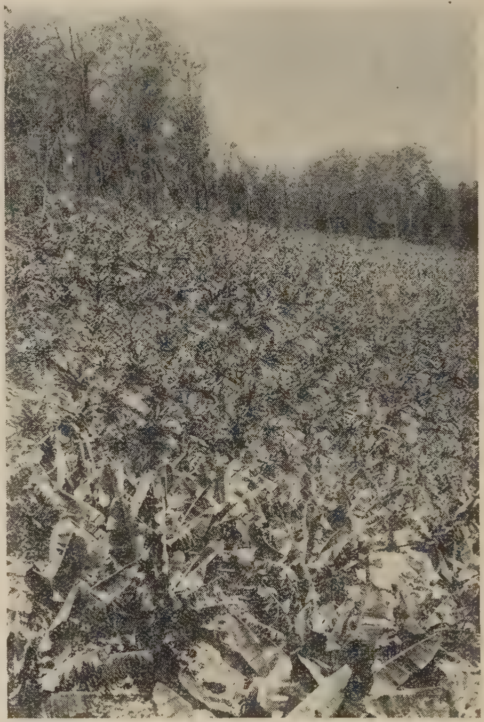


FIGURE 62.—A successful banana plantation, won from the original forest, at Kandanga, near the Queensland coast. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

C. F. 2. *North Coast* (*New South Wales*)—Chief maize district in Australia. Some oats and lucerne.

C. F. 3. *Sydney District*—Market gardens, orchards. Little maize and oats.

C. F. 4. *South Coast* (*New South Wales*)—Some sheep, maize, and oats.

C. F. 5. *Gippsland*—Orchards, some maize, sheep, oats, potatoes, little beet sugar.

C. F. 6. *Central Tasmania*—Oats, orchards, little wheat, some sheep. Potatoes in north.

3. FOREST-CROP—LESS IMPORTANT DAIRYING BELT

F. C. 1. *North Queensland Coast*—Sugar, tropical fruits.

F. C. 2. *Central Queensland Coast*—Like North

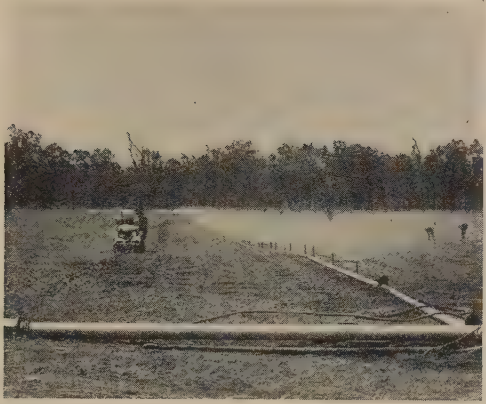


FIGURE 63.—Intensive tobacco culture in a continent of generally extensive agriculture. Planting and irrigating tobacco at Texas, South Queensland. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

Queensland coast, but less sugar. Chief cotton area in Australia.

F. C. 3. *Emerald District*—Chiefly cattle, but a little agriculture.

F. C. 4. *West Swanland* (*West Australia*)—Orchards, timber, some sheep.

5. FORESTS

Apart from the jungles and thick forests of the coasts, which are giving place to agriculture and are described under Forest-Crop, there are large areas of open forest in highland country which are little altered from their original condition. Cattle and sheep find pasturage in many parts of the highlands, their density decreasing to the south as the highlands become bleaker and less closely wooded. The New England Plateau has some agriculture in the west, but the high Blue, Bogong, and Tasmanian Plateaux are of little importance even for stock.

5. FOREST—CHIEFLY SPARSE CATTLE

F. 1. *New England Plateau*—Dense sheep and many cattle.

F. 2. *Blue Plateau*—Many cattle and sheep, little agriculture in valleys.

F. 3. *Bogong-Kosciusko Plateau*—Few cattle on highlands, sheep in valleys.

F. 4. *Monaro Uplands*—Important cattle and sheep.

F. 5. *Tasmanian Plateau*—Few sheep and cattle some sawmills.

PASTURE

Three somewhat arbitrary types of pasture country have been delimited, based partly on the density of the stock. Much the same kinds of vegetation are found throughout, various types of Acacias being the dominant tree. In the north with summer rain, grasses are dominant; in the south with winter rain, saltbush is more abundant.

6. PASTURE-BUSH

This type of country is almost wholly found in tropical lands, with a rainfall of 20 inches, nearly all falling in summer. Mitchell grass (*Astrebla*) is common, while false spinifex (*Triodia*) occurs in the sandy districts. Brigalow (*Acacia sp.*) is abundant in clumps with many similar trees from 10 to 30 feet high. *Casuarina*, *Bauhinia*, and *Eremophila* are associated with them. There is no agriculture.

STOCK

In the west in Kimberly there are about 200,000 sheep and 600,000 cattle. In the Victoria River Basin (Northern Territory) there are about 500,000 cattle and no sheep. In the Queensland region there are 9 million sheep and about 3 million cattle.

6. PASTURE-BUSH—IMPORTANT STOCK

(N. B.—Future sporadic agriculture is possible)

P. B. 1. *Queensland Downs*—Important cattle and fair sheep.

P. B. 2. *Longreach District*—Important sheep, fewer cattle, valuable artesian water.

P. B. 3. *Fitzroy-Victoria Basins*—Important cattle, few sheep in west.

8. BUSH-PASTURE

Along the north coast of Australia is a region with a fairly heavy summer rainfall (varying from 30 to 50 inches), but which is of very little economic importance. The soils are poor, the grasses are rank, and ticks are fairly prevalent. As a conse-

FIGURE 64.—A mango tree heavily laden with luscious fruit near Brisbane. (Courtesy of Dept. of Agric. and Stock, Govt. of Queensland.)

quence cattle are not numerous, though there are 500,000 in the Cape York Peninsula. The vegetation is much like that in the Pasture-Bush region; but Pandanus, Baobab, and other tropical forms occur.

8. BUSH-PASTURE—SPARSE CATTLE

B. P. 1. *Peninsula*—Fair cattle country.
B. P. 2. *North Kimberley*—Rugged, possible for cattle.
B. P. 3. *Arnheim region*—Poor pastoral possibilities.

7. PASTURE

In this region the rainfall is only from 10 to 20 inches, and falls chiefly in summer. The trees are smaller and occur in clumps, especially along the beds of the intermittent streams. They are largely acacias, mulga being common. Mallee is abundant in the south with poplar-gums, white box, etc. Eremophila and Myoporum are common small trees. Mitchell grass and saltbush both occur.

STOCK

There are about 7½ million sheep and 1 million cattle in this portion of the continent.

7. PASTURE—IMPORTANT STOCK
(N. B.—Future sporadic agriculture possible)

P. 1. *Southwest Queensland*—Artesian water, both sheep and cattle.
P. 2. *Darling Basin*—The chief merino country (few cattle). Irrigation along the Murray River.
P. 3. *Barkly Uplands*—Cattle only.

9. DESERT-PASTURE

This is a region of low rainfall (around 10 inches) and high evaporation (around 100 inches). The vegetation is intensely xerophytic, consisting essentially of mulga (Acacia) and false Spinifex. But grass and saltbush occur in places, especially in the flat swampy lands into which the intermittent rivers drain. Some of the mulgas and spinifex are eaten by stock, which thus survive the droughts. The region is capable of producing fine cattle, provided they have water enough and are given enough area per head. The total numbers are not large, considering the huge area involved. There are about 2½ million sheep and 150,000 cattle in the Western Australian portion. In South Australia one million sheep and 100,000 cattle, and in Northern Territory about 69,000 cattle and 4,000 sheep live in the Desert-Pasture region.

9. DESERT-PASTURE REGION—VERY SPARSE STOCK

D. P. 1. *Western Plateau*—Sparse cattle and sheep.
D. P. 2. *Lake Eyre Lowlands*—Sparse cattle and sheep. Some Artesian water.
D. P. 3. *Macdonnell Highlands*—Sparse cattle and sheep.
D. P. 4. *Barrow Creek Uplands*—Almost empty.
D. P. 5. *Nullarbor*—Almost empty.

DESERT

In this area of over half a million square miles, the country consists largely of fixed dune, hamada, or pebble (gibber) plains.

10. DESERT—UNINHABITED

D. 1. *Western Desert*—Largely fixed dunes or hamada.
D. 2. *Arunta Desert*—Largely fixed dunes.

It contains no stock, and is entirely uninhabited by white settlers.

THE PASTORAL AND AGRICULTURAL INDUSTRIES OF KENYA COLONY AND PROTECTORATE

Earl C. Case

Geographer, University of Cincinnati

THE Colony and Protectorate of Kenya are very nearly bisected by the equator (Fig. 1), and yet the major activities of the people would scarcely suggest this low-latitude position. The most important native industry is the pasturing of cattle, sheep, and goats, which number at present almost ten million head. Such richness in useful animals is foreign to most equatorial areas. It is in sharp contrast to conditions within the hot humid forests of western equatorial Africa, where one may travel hundreds of miles without seeing a single herd of cattle or flock of sheep or goats except, perhaps at some missionary station, where a few cows may be kept for dairy purposes.

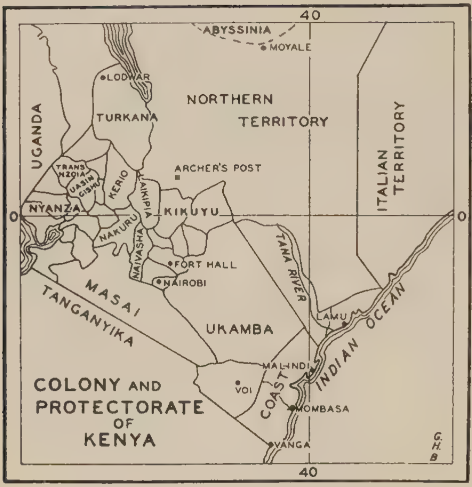
The agriculture of Kenya varies greatly from one section to another, both in the kinds of crops grown and in the methods of cultivation. The heart of Kenya, however, is the upland area of the southwest where European settlers are developing modern plantations and ranches on an extensive scale. This area has been brought under cultivation with remarkable rapidity and is today the source of the major exports of the Colony. The most important commercial crops are maize and wheat—grains usually associated with temperate climates; coffee, a product grown most abundantly in subtropical areas; and sisal, a drought-resisting plant which requires long dry periods for the production of high-quality fiber. The distribution of the various crops of Kenya is closely related to climatic conditions which in turn depend largely upon topography and proximity to the sea (Figs. 2 and 3).

CLIMATE AND AGRICULTURE

Kenya is rather sharply divided into three agricultural units based primarily on differences in rainfall and temperatures. They are: (1) the hot humid southeastern coast suited to the production of many tropical products; (2) the remaining lowlands (about 65 per cent of Kenya) where, as a result of heat and scant rainfall, most of the land still lies waste or affords uncertain pasture; and (3) the uplands of the southwest where, under European management, the cultivation of the land is increasing rapidly.

Although the Colony and Protectorate cover an area of 209,000 square miles, less than one-fourth of it has rainfall sufficiently heavy and reliable for the promotion of agriculture, and perhaps another one-half supports poor to fair pasture. The remaining one-fourth is desert or near-desert.

The low narrow coastal strip, varying in width from 3 to 20 miles, is hot, debilitating, and ill-suited as the home of European peoples. Within the southern part annual precipitation exceeds 40 inches and is sufficient for the cultivation of rice, maize, coconut palms, mango palms, sisal, bananas, and many other prod-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ABYSSINIA
MOYALE
LODWAR
NORTHERN
TERRITORY
TURKANA
UGANDA
TRANS NZOIA
UASIN GISHU
ARCHER'S POST
KERIO
LAIKIPIA
NYANZA
KIKUYU
NAKURU
NAIVASHA
FORT HALL
NAIROBI
TANA RIVER
ITALIAN TERRITORY
MASAI
TANGANYIKA
UKAMBA
LAMU
OCEAN
INDIAN
MALINDI
COAST
VOI
MOMBASA
VANGA
COLONY AND PROTECTORATE OF KENYA
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FIGURE 1.—Place map of Kenya.

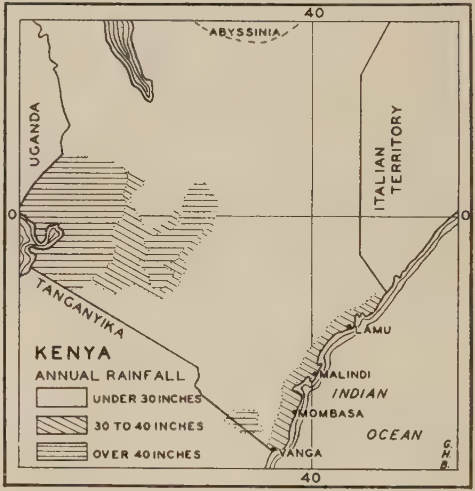
ucts. Towards the north, the rainfall decreases and becomes more concentrated until at Lamu, the bush-covered desert comes down to the coast and none of the land is cultivated[1] (Figs. 4 and 5).

Just back of the coastal strip extends a low range of hills which, although rocky and eroded, has sufficient precipitation to support a sparse population.

Behind these hills lies the *Nykia*, an area usually described as a desert belt, except during the rains when for a short period vegetation is more abundant. The grass and sedge which grow in little tufts are so widely scattered that the general tint of the landscape is that of the soil. Most of the plants are thorny or fleshy, as is usual within all desert areas. The average annual rainfall is about 25 inches in the southern part of the *Nykia*, but towards the north it decreases to 15 inches or less (Fig. 5). The average, however, is not very significant because of the wide variation from one year to another. In 1926, the rainfall at Voi was but 6.34 inches.

The Northern Frontier Province and Turkana, which occupy slightly more than one-half of Kenya, have an exceedingly light and unreliable rainfall. Part of Turkana is true desert. The average annual rainfall at Lodwar, just west of Lake Rudolf (Fig. 1), is but 5.36 inches[2] and the country takes on something of the appearance of the Sahara. A season of exceptionally light rainfall in Turkana is the cause of many raids in which the pastoral tribes attempt to replenish their food supply by appropriating the flocks and herds of their neighbors.

The Northern Frontier Province is almost entirely desert and the population is less than one per square mile. Except for the production of a little maize on some of the higher elevations, and some millet along the Tana River, agriculture is non-existent.[3] At Wajar, the average annual rainfall is but 7.87 inches (Fig. 5) and during dry years it is much less. At Archer's Post, on the border of the


40
ABYSSINIA
UGANDA
ITALIAN TERRITORY
0
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TANGANYIKA
KENYA
ANNUAL RAINFALL
UNDER 30 INCHES
30 TO 40 INCHES
OVER 40 INCHES
LAMU
MALINDI
INDIAN
MOMBASA
OCEAN
VANGA
G. H. B.
40

FIGURE 2.—Rainfall map of Kenya.

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[1] Handbook of Kenya and Protectorate, 1920, p. 30.

[2] Colony and Protectorate of Kenya, Meteorological Records, Dept. of Agr., 1926, p. 9.

[3] Op. cit., Native Affairs, Dept. Ann. Report. 1926, p. 46.

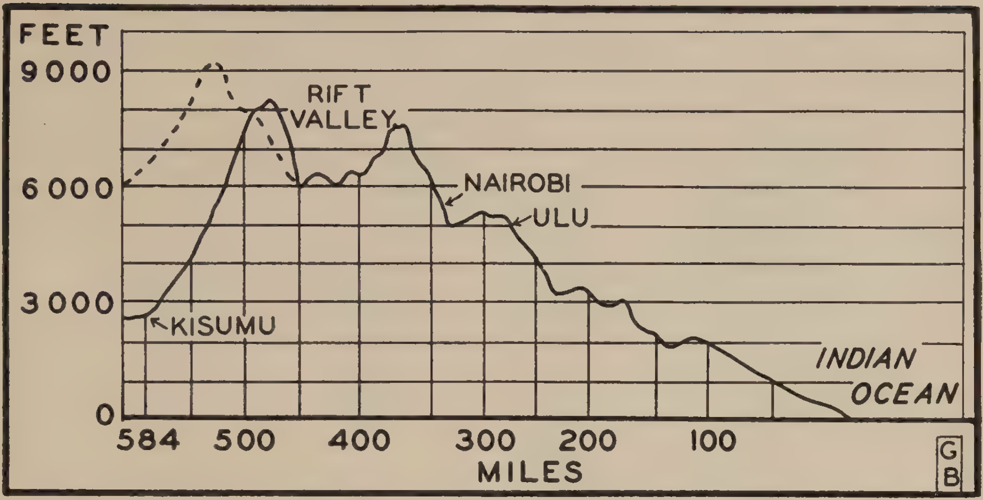

FIGURE 3.—The solid line represents the elevations along the Kenya-Uganda Railway. The dotted line represents the elevations along the Uasin Gishu branch line.

Highlands the average annual precipitation is 15.92 inches, but during nine or ten months of each year the ground is parched by the tropical sun.

The Highlands of southwest Kenya present a much more encouraging outlook. This area, consisting of about 35,000 square miles, is the best watered part of Kenya (Fig. 2), supports more than three-fourths of the total population, and has recently become the dominant agricultural center of the Colony. Even here, however, the rainfall is by no means as reliable as it is in most parts of humid United States. Normally there are two rainy seasons (Fig. 5), but at times one or both of these practically fail. Years of abundant precipitation and excellent pastures and crops are followed by protracted droughts and famine. The last severe famine of Kikuyu occurred in 1898–1899, when the rainfall was less than one-half the average for the eight preceding years. This drought of eighteen months' duration caused a famine "unparalleled within native memory. . . . It was contended by survivors that three out of every four of the Kikuyu residents, in extensive stretches of country, died either from famine or small pox."[4]

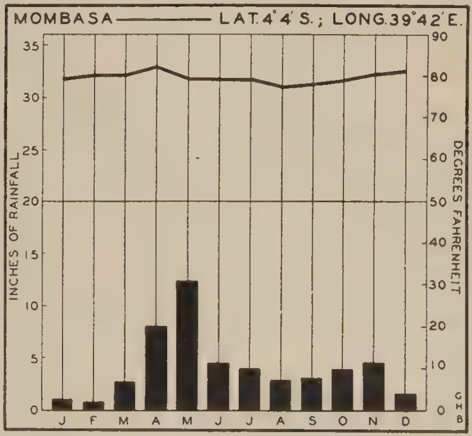

FIGURE 4.—Rainfall by months at Mombasa.

While the famine was at its worst, two steps were being taken by the British which should prevent, or at least alleviate, famine conditions in the future: first, the methods of transportation were being improved and soon railways and motors began to replace human carriers; and second, new crops and scientific methods

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[4] Ross, W. McGregor. "Kenya from Within." Geo. Allen & Unwin, London, 1927, p. 62.

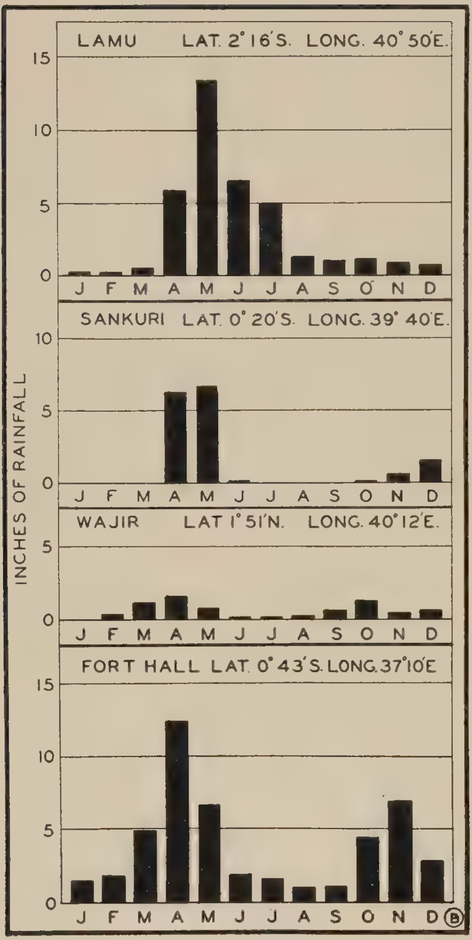

FIGURE 5.—Rainfall by months at four stations in Kenya, indicating its seasonality.

of agriculture were being introduced into the Highlands by European settlers.

NATIVE AGRICULTURE

The beginnings of agriculture in Kenya are obscure. It is most probable that a few centuries ago all of the tribes were pastoral and hunting peoples. Even when the British settlers arrived at the beginning of the present century, flocks and herds represented the sole wealth of the most powerful tribe—the Masai.[5] It was preëminently this tribe which held vast tracts of land from being occupied and used, thereby keeping them open for European penetration. To the Masai also may be attributed the persistence and increase in wild fauna which make Kenya Colony one of the most richly stocked big-game countries in the world. These pastoral people waged unceasing war against the lion, thereby restricting the serious toll that it levied upon their flocks and herds and upon the antelope of the plain. They did not kill and eat the game themselves, and they kept hunting tribes off the prairies where the game abounded.

The chief food of the Masai was sour milk, meat, and blood from their own herds. They drank the blood while it was still warm, and just as it was drawn from a vein in the animal's neck, after which the wound was closed and the animal turned loose to recover. The diet of certain other tribes was obtained almost exclusively from wild game of which there was an abundance in Kenya, while still other tribes had developed primitive agriculture to supplement the food obtained from hunting and pastoral pursuits.

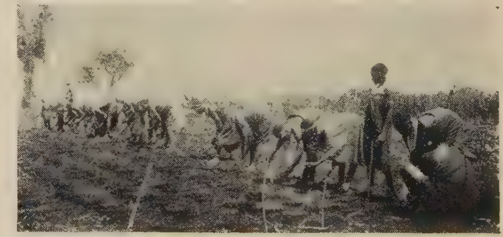

FIGURE 6.—The natives of Kenya planting corn with sharpened sticks. Mr. L. W. Kephart, who took the picture, said that this is the only group of men he saw working on native farms within Kenya. Most of the agricultural work is done by women. (Courtesy of L. W. Kephart, Foreign Crops Division, U. S. Dept. of Agric.)

Early records seem to indicate that the Kikuyu tribes had sur-

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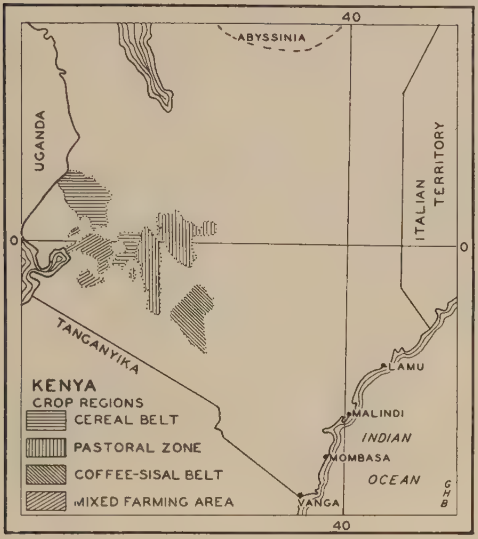
[5] Buxton, M. Aline. "Kenya Days." Edward Arnold & Co., London, 1927, p. 56.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ABYSSINIA
UGANDA
ITALIAN TERRITORY
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TANGANYIKA
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MOMBASA
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VANGA
GHB
KENYA
CROP REGIONS
CEREAL BELT
PASTORAL ZONE
COFFEE-SISAL BELT
MIXED FARMING AREA

Figure 7.—The shaded areas represent sections of the Highlands which have been alienated —set aside for European settlement.

passed all others in the development of agriculture. Their territory, situated in eastern Kikuyu, was described by Mr. Francis G. Hall, after whom Fort Hall is named, as being about 100 miles in length and 15 to 18 miles in breadth. He wrote: "With the exception of small patches of excellent grass, which are kept for grazing purposes, and a few small swamps, every available piece of ground is under cultivation, and the district may be described as one vast garden." Still earlier Captain Lugard had reported: "The cultivation of Kikuyu is prodigiously extensive, indeed the whole country may be said to be under tillage. Beans of various kinds are the staple, grain being comparatively little grown at present."[6]

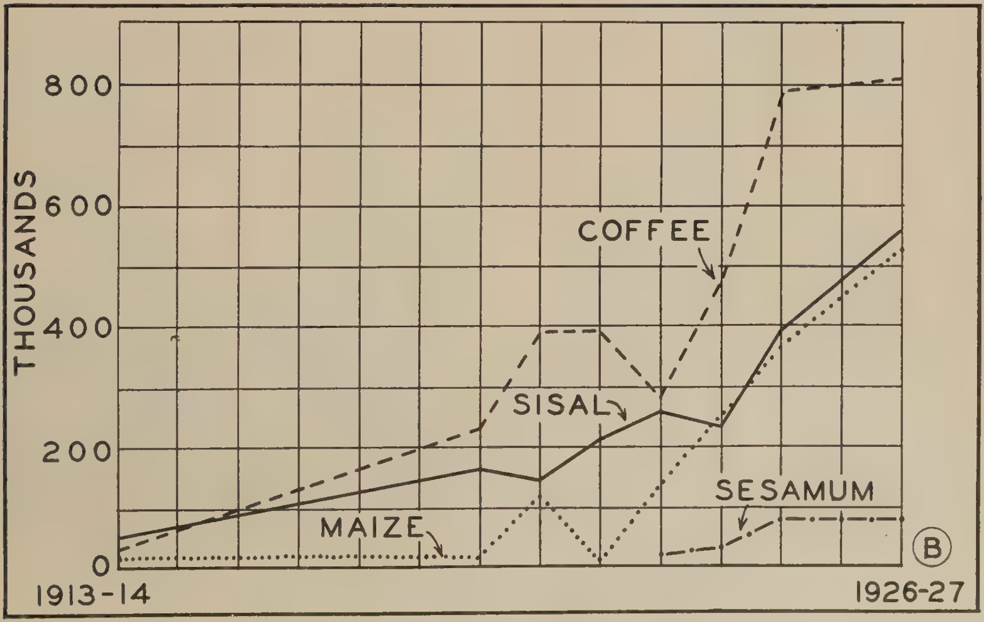

Figure 8.—The principal exports of Kenya (000 omitted).

There is evidence that at one time agriculture was highly developed along the coast by Arab planters, but with the abolition of slavery, and the relaxation of despotic control, the coast peoples have sunk back into the lethargy from which their conquerors had aroused them.

No accurate data have been col-

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[6] Lugard, Captain F. D. "The Rise of Our East African Empire," p. 328.

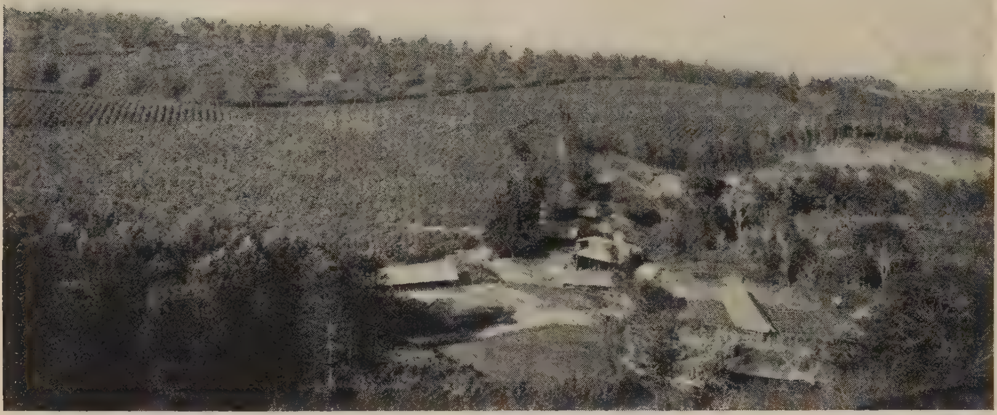

FIGURE 9.—A coffee plantation of Kenya. The large trees in the background are grown to shade the coffee trees and to protect them from the hot drying winds.

lected which indicates the extent of native cultivation. It is known, however, to have been small before the arrival of white settlers, except along the coast, on the eastern border of the Highlands, and within a few other scattered areas. Previous to the construction of the Kenya-Uganda Railway, the Mau Plateau contained vast stretches of land entirely uninhabited; today these lands constitute the principal cereal-producing area of Kenya.

Since 1900, agricultural development has gone forward with rapid strides, primarily on European plantations. Native agriculture is chiefly the subsistence type and but little surplus is produced for export. In 1927, the exports from European farms were valued at more than ten million dollars, whereas, the non-European exports, including those produced by Indian farmers, were worth only about one-fifth as much.[7]

The natives possess but little agricultural machinery. In most cases the ground is merely dug over lightly with hoes or sharpened sticks and the crops planted in poorly prepared soil (Fig. 6). Plows are sometimes purchased by communities, but rarely by individuals. The most encouraging results thus far were obtained in 1926, when the natives of Nianzi purchased 87 plows. Yet, it must

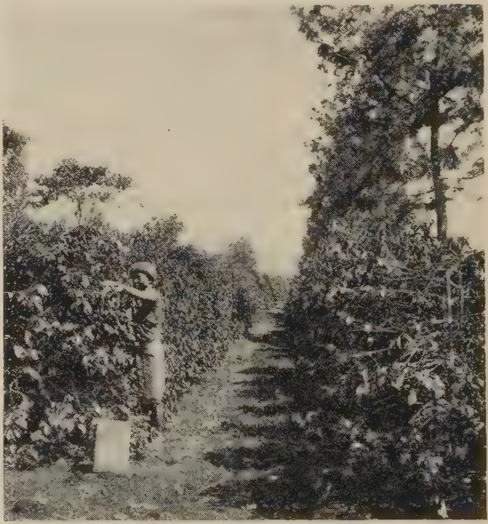

FIGURE 10.—Picking coffee in Kenya. (Courtesy of Foreign Crops Division, U. S. Dept. of Agr.)

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[7] Colony and Protectorate of Kenya, Agricultural Census, Nairobi, 1928, p. 26.

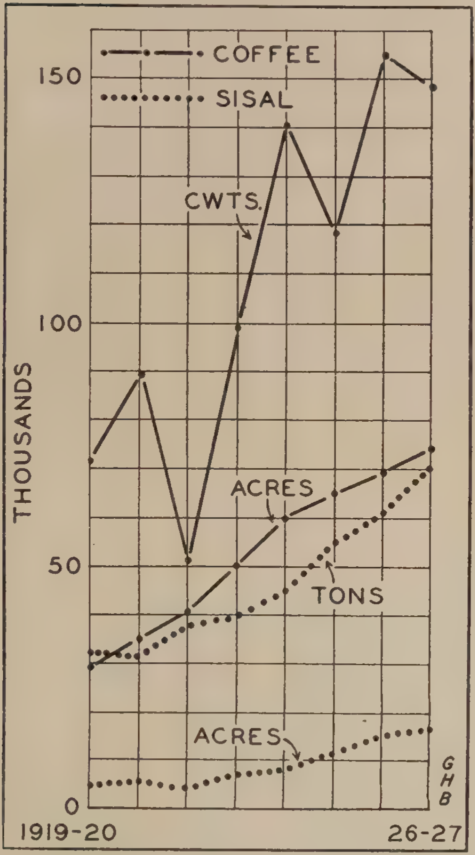

FIGURE 11.—Acreage and production of coffee and sisal (000 omitted).

be remembered that this record sale represented only one plow for each 120 square miles of territory or for each 115,000 people.

NATIVE AGRICULTURE VERSUS PLANTATION AGRICULTURE

It may be somewhat surprising to learn that native cultivation is developing more rapidly in the hot lowlands of Uganda than on the pleasant uplands of Kenya. This is largely a result of the difference in labor policies of the two colonies. In Kenya the natives are urged to work on European plantations, and if the number of willing workers is not sufficient to meet the planters' needs, more are recruited, by coercion if necessary. As a result the number of natives under European employment increased from 12,000 in 1912, to 185,000 in 1927. This labor policy of Kenya is in sharp contrast to that fostered in Uganda, Belgian Congo, the Gold Coast, and other tropical lowlands where the natives are encouraged to till their own land and to sell the surplus products to European merchants. The differences in policy is due to the fact that the Kenya Highlands are suited to white settlement, while within the equatorial lowlands the oppressive heat and humidity prevent true European colonization. The result of the labor policy of Kenya as compared with that of other areas is clearly shown in Table 1.

TABLE 1

PERCENTAGE OF ADULT MALE POPULATION
UNDER EUROPEAN EMPLOYMENT*

Territory	*Adult Male Population*	*Number Continually Employed*	*Per Cent of Adult Male Population Employed*
Kenya	500,000	169,000	33.8
Belgian Congo	2,100,000	300,000	14.3
Gold Coast	495,000	25,000	5.4
Uganda	629,000	25,000	4.0
Nigeria	3,732,000	80,000	2.1

* Buell, Raymond L. "The Native Problem in Africa." The Macmillan Co., 1928, p. 346.

It is estimated that by 1929 more than 40 per cent of the adult male population of Kenya will be needed to care for European plantations, unless labor-saving machinery or labor-saving crops are introduced on a larger scale.

NATIVE PASTORAL INDUSTRY

The tending of flocks and herds is the most important native occupation in Kenya, and the number of cattle, sheep, and goats owned per capita is more than twice that of the United States. Two and one-half million people own approximately ten million head of livestock (Fig. 2), but unfortunately most of the native animals are of inferior quality.

TABLE 2

NATIVE OWNED LIVESTOCK OF KENYA, 1926

Cattle	3,298,000
Goats	3,698,000
Sheep	2,535,000
Camels	60,000
Donkeys	35,000
Horses and Mules	100

In the hot coastal lowlands, 60,000 camels and 10,000 donkeys represent almost the only beasts of burden except man. One traveler has written, "The donkey and the camel make an incongruous appearance as they walk side by side heavily laden with merchandise." Oxen are poorly suited to the coast because of the ravages of the tsetse fly, rinderpest, and the coast fever.

The coast also supports about 200,000 sheep and goats. The sheep do not grow wool, but hair, and, like the goats, are raised primarily for their meat and hides.

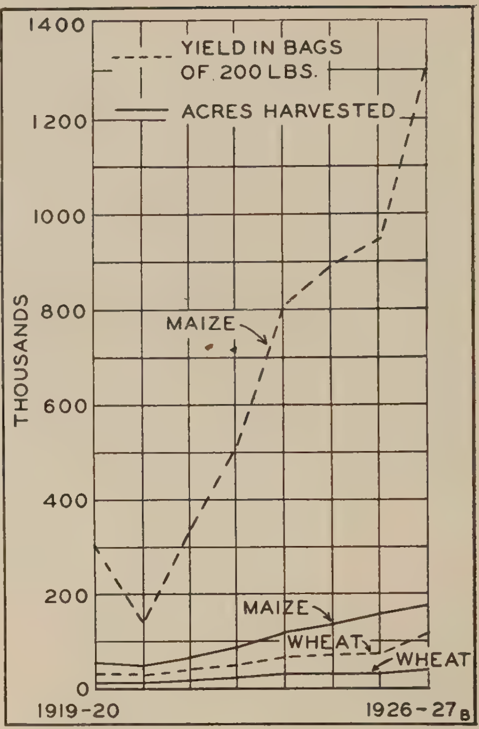

FIGURE 13.—Maize and wheat acreage and production (000 omitted).

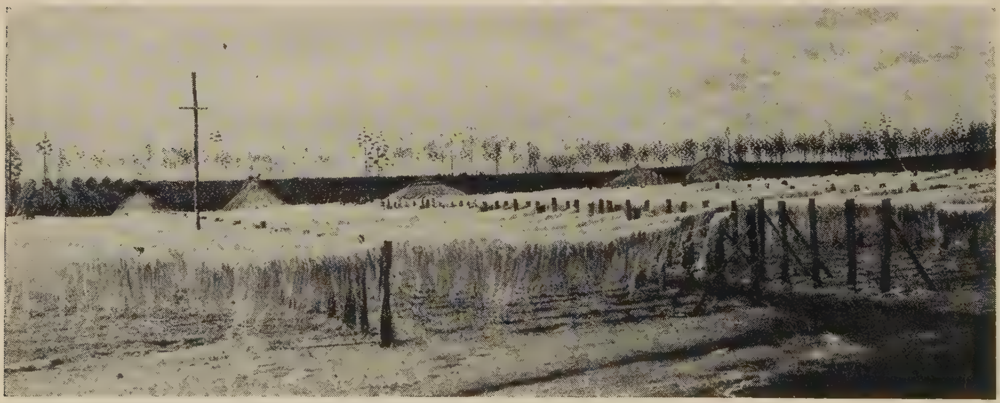

FIGURE 12.—The background shows a field of mature sisal, in the center may be seen piles of leaves ready for the decortication plant, and the foreground shows the sisal fiber drying in the sun. (Courtesy of Foreign Crops Division, U. S. Dept. of Agr.)

The Northern Frontier and Ukamba, which include slightly more than 60 per cent of Kenya, support about 1,000,000 head of cattle and 1,800,000 head of sheep and goats. The Tana River and the scattered areas of higher elevations are the life of these provinces. Although most of the Tana River has been included in the Coast Province, the climate is similar to that of the adjoining parts of the Northern Frontier. The Tana

River which floods its banks every winter is sometimes called the Nile of Kenya. These floods provide moisture for pasture and for the cultivation of millet.

The best grazing areas of Kenya are found in the Highlands where more than two-thirds of all the livestock are pastured. Here the pastures are richer and more reliable than in the Lowlands, and the cattle are immune from the ravages of the tsetse fly. There have been, however, serious outbreaks of coast fever, rinderpest, and pleuro-pneumonia.

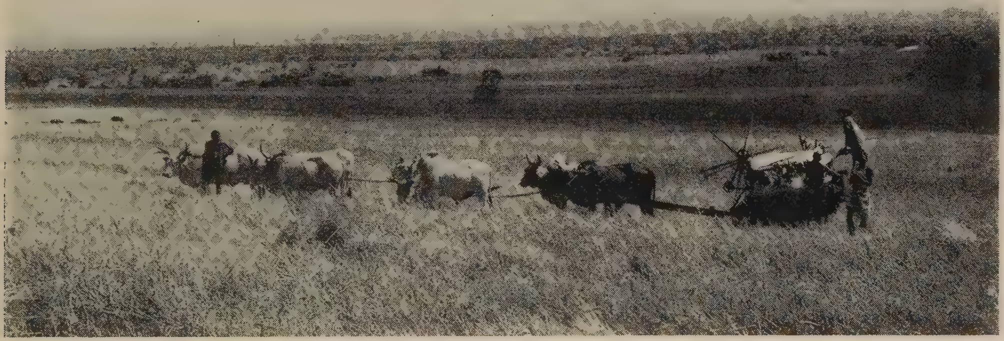

FIGURE 14.—A wheat field within sight of the equator. Upon the high tableland of the Uasin Gishu Plateau, excellent crops of wheat are grown. The American-made binder is pulled by oxen, as horses do not thrive within this area. (Courtesy of Foreign Crops Division, U. S. Dept. of Agr.)

EUROPEAN PLANTATION AGRICULTURE

It is interesting for one to note the important part that transportation plays in the development of plantation agriculture.

THE NECESSITY OF RAILWAY COMMUNICATION

Amazing tales of the wonderful temperate-zone climate and fertile soils of the Kenya Highlands were told with increasing frequency after 1885. Early travelers in East Africa also recorded the existence of large areas of land totally unoccupied except for big game, and of other areas wastefully used for grazing. Yet, the rapid development of these lands was out of the question because of poor transportation facilities. The only products which could be exported were slaves, who could walk to market, and ivory, which could bear the cost of expensive transportation. The Highlands of Kenya were seldom raided for slaves, partly because of the difficulty of crossing the desert back of the coast, and partly because of the fear of the fierce Masai, who occupied part of this upland area. Occasionally, however, when traders found ivory difficult to obtain, they resorted to the slave traffic so as not to return to the coast empty-handed.

The first requisite for the development of plantation agriculture was some improved method of transportation. The Highlands lie 300 to 500 miles from the coast. No navigable rivers afford a highway to the sea, and beasts of burden could not be used because of the ravages of the tsetse fly. Human portage was almost the only means of transportation, and that was costly. It was estimated that human portage in legitimate trade cost about 75 cents per ton per mile. Thus, each ton transported from the Highlands cost approximately 300 dollars carrying charges alone—a cost prohibitive for most agricultural products.[8] Apart from the monetary expense, human portage in this part of Africa was extremely costly in life. Two thousand natives died of dysentery in a single caravan while crossing Kenya from the Uganda border. In addition, these porters were the means of conveying epidemics all along the route and into their home villages. Under such conditions it was only natural that plantation agriculture should await the construction of a railway which was completed across the Kenya Highlands to the Uganda border in 1901.

EUROPEAN SETTLEMENTS

Even before the railway reached the Highlands, a few bold adventurers had settled in the most favorable places along the route projected. Rapid settlement did not begin, however, until 1903–1904, and even then travelers along the most beaten highway might suddenly find themselves marching into a herd of elephants, which still roamed in this area. During the first few years the settlers needed machinery, breeding stock, seed, clothing, and other products for the development of plantations, but they had little to sell in return. As late as 1910, the exports from the Highlands were negligible except for hides and skins which were purchased from the natives. During the next decade the production of coffee and sisal increased rapidly, and since 1920 maize and wheat have become important crops.

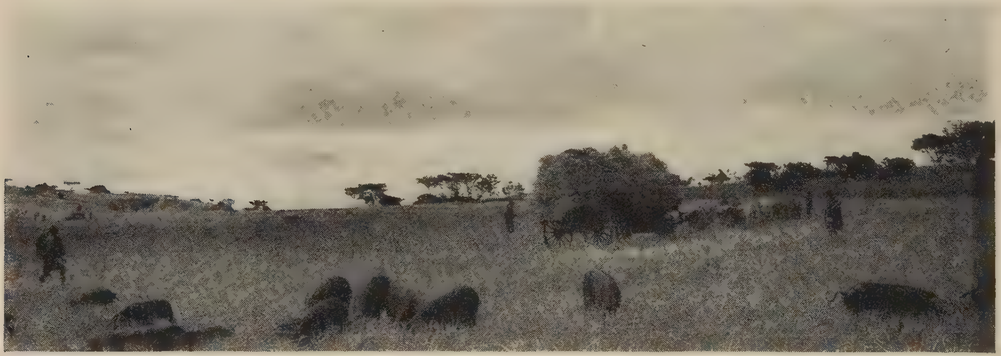

FIGURE 15.—The Uasin Gishu Plateau is well suited to hog-raising. (Courtesy of Foreign Crops Division, U. S. Dept. of Agr.)

THE COFFEE-SISAL BELT

The alienated area situated within the southeastern part of the Highlands is primarily given to the production of coffee and sisal. In 1927, these two crops occupied 90 per cent of the total area planted in this district and were given practically the entire time and attention of the English settlers (Fig. 7).

COFFEE THE MAJOR COMMERCIAL CROP

Almost immediately after settlement, coffee became the major commercial crop and has retained first position to the present time (Fig. 8). The cultivation of coffee is limited almost exclusively to European plantations. The natives are effectively prevented from growing it by the Coffee Plantation Registration Ordinance, which requires every coffee grower to secure an annual license costing 30 shillings.[9] Even if this sum were not prohibitive to the natives, the district commission can refuse to issue a license.

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[8] Fraser, Donald. "The New Africa, 1928," p. 68.

The coffee plantations are all situated between 4,000 and 7,000 feet in altitude, the best results being obtained between 5,000 and 6,000 feet (Figs. 9 and 10). The general tendency is for the lower altitudes to produce a heavy yield of low-quality coffee and the higher altitudes to produce a lighter yield of the better quality.[10] The area of most extensive cultivation and abundant production is situated on the southeastern border of the Kikuku Plateau (Figs. 1 and 8), at an altitude of 4,000 to 5,000 feet. It is near the Uganda Railway with but a short haul to the coast. The neighboring districts are densely populated, and provide many laborers. Yet, during the harvest season the local supply is insufficient to meet the needs of the coffee planters, and recruiting agents are sent among distant tribes to secure additional workers. In this way many married men are taken from the reserves for a protracted period of time. Their absence creates unsatisfactory social conditions which are detrimental to family life.[11]

Although the coffee planter frequently is handicapped by a shortage of labor, his greatest fear is that of a drought or other adverse weather conditions. During the dry seasons hot winds from the north quickly injure the crop. In order to reduce the exposure to these winds many of the plantations are situated on south-facing slopes. Throughout the Highlands hail storms are frequent and cause much damage, and on the higher elevations the crop is adversely affected by the low temperatures at night.

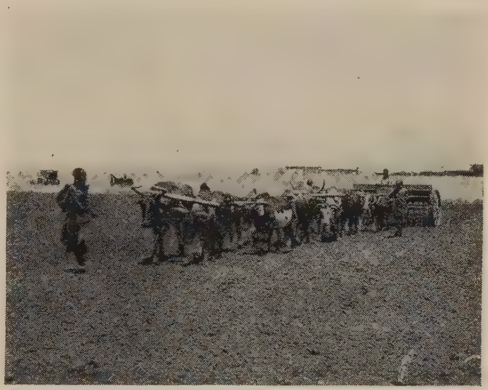

Figure 16.—The broad level uplands of Uasin Gishu are well adapted to the use of large-scale machinery. An American-made drill is being used in sowing wheat. (Courtesy of Foreign Crops Division, U. S. Dept. of Agr.)

The acreage yield of coffee varies from year to year (Fig. 11). Evidencing the truth of this is the following statement made by a resident of Kenya: "As long as I have lived in Kenya it has always been an abnormal year. In 1920, it rained in sheets; in 1921, my garden burnt to dust by the blazing sun; in 1923, we were marooned for weeks when floods and cloudbursts washed all our bridges away. Last year (1924) there was so little rain that people, who had budgeted on a hundred tons of coffee, found themselves in great disfavor with their bank managers, and only fifty tons to sell."[12]

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[9] Kenya Coffee Ordinance, 1918, p. 9.

[10] "Kenya, Its Industries, Trade, Sports, and Climate," Kenya Empire Exhibition Council, 1924, p. 58.

[11] Kenya Colony and Protectorate, Report of the Labor Commission, Nairobi, 1927, p. 32.

In spite of climatic handicaps and labor difficulties, the coffee industry has prospered and the acreage and production have increased. The undeveloped area suited to the crop is still large, but the increasing shortage of labor is likely to be an effective check to continued and rapid expansion.

SISAL

Sisal ranks second only to coffee as a commercial product of Kenya, and is the most reliable of the commercial crops of the Colony. It requires a tropical climate with moderate to light rainfall and can stand long periods of drought. During the year 1921–1922, when the rainfall was much below normal, injuring both the coffee and the maize crops, sisal did exceptionally well (Fig. 11).

Sisal is grown on the coast, along the Uganda Railway, and in the Highlands. The area of greatest production is near Fort Hall where the sisal industry vies with that of coffee for the labor of the densely populated Kikuyu Plateau.

Since Kenya has two growing seasons each year, the sisal plant grows more rapidly than in its original home—Yucatan. It also dies younger, but the number of leaves harvested from each plant before death is about the same in each country.

In the Lowlands the fields are not cultivated before planting. They are merely cleared of vegetation after which holes are dug for the bulbils. This method is adopted partly because of the difficulty of keeping oxen in the hot humid climate, and partly because the coral land of the coast does not lend itself to cultivation.

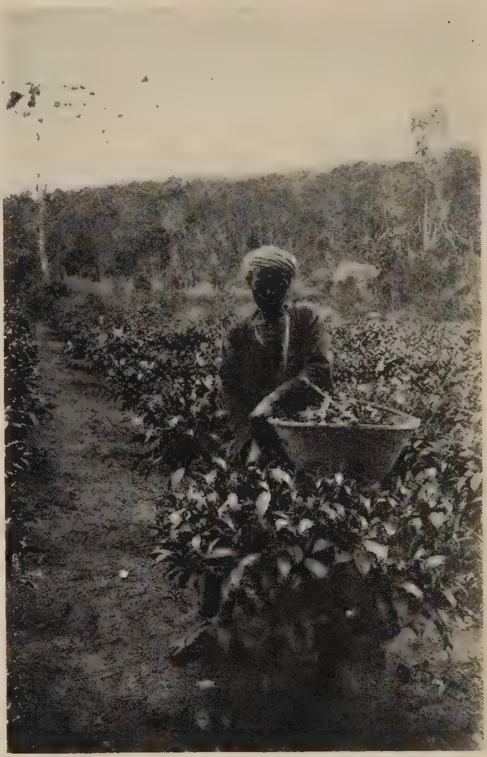

FIGURE 17.—Picking tea within the western Highlands of Kenya. (Courtesy of Foreign Crops Division, U. S. Dept. of Agr.)

Within the Highlands the ground is thoroughly tilled in order that other crops such as maize, beans, or wheat may be cultivated along with the sisal during the first two years.

Sisal production is primarily a corporation industry. The manufacture — decortication — requires costly machinery; large expense is necessary to house and pay the laborers, and economic production requires the cultivation of several hundred acres—a plantation large enough to steadily supply a factory. Moreover, there is no financial return during the first two or three years. These conditions have effectively prevented native production of sisal. Thus, the two major crops of Kenya are grown almost exclusively on the plantations of European settlers and under European management but by native labor (Fig. 12).

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[12] Buxton, M. Aline. "Kenya Days." Arnold & Co., London, 1927, p. 78.

THE CEREAL BELT

Cereal production is as dominant just west of the Great Rift Valley and within the northeastern part of the Highlands as coffee and sisal are within the southeastern part of the Highlands. In 1927, Nakuru, Uasin Gishu, and Trans Nzoia grew 88 per cent of the maize, 80 per cent of the wheat, and 78 per cent of the barley of Kenya. These three crops also occupied 89 per cent of the total area planted within these districts (Figs. 1 and 7).

Maize, which requires abundant moisture, is cultivated almost exclusively upon the Mau Plateau—the Highlands west of the Great Rift Valley. Wheat is grown primarily upon the Plateau, but excellent crops have been harvested within the Valley in spite of its light and uncertain rainfall. However, the Valley is primarily given to pasture. Mr. W. S. Bromhead, in writing of this area, says: "East of Nakuru (a city near the western margin of the Rift Valley) one gradually works out of the mixed-farming country and approaches the characteristic Marino sheep and rich fattening pasture lands of the Rift Valley." [13]

The distribution of cereals is not only related to rainfall but also to topography and transportation facilities. Between Nakuru and Uasin Gishu is a mountainous area which has but little land suited for cultivation, and it is still occupied by the natives. Farther north within Uasin Gishu and Trans Nzois are large plateau areas where the land is relatively level and where machinery can easily be used in large-scale crop production. Uasin Gishu is the foremost province in the use of modern machinery, where, in 1927, more than 500 tractors were in operation. The oxen, however, still do most of the heavy work (Figs. 14 and 15). In 1927, more than 50,000 of the 83,000 trained oxen of Kenya were found on the farms of Nakuru, Uasin Gishu, and Trans Nzoia, while but 7,000 were used in the coffee-sisal area of Kikuyu.

Because of the increasing use of large-scale machinery the cereal planters have not been seriously handicapped by the shortage of labor (Fig. 16); consequently, maize production is increasing more rapidly than that of any other crop (Fig. 13).

The most effective check to the rapid expansion of cereal production has been the lack of adequate transportation facilities and of conditioning plants to prepare the grain for shipment. Wheat and maize can not stand the cost of long hauls by oxen, nor can they be shipped long distances through the hot moist tropics without first being prepared for transit through such a climate. Several conditioning plants have now been erected to prepare maize for export. The one situated at Kilindini is the largest of its kind in the world. The purpose of the plant is to remove the excessive moisture in the corn and to kill the weevils and their eggs. If not so treated, the grain will rapidly deteriorate in transit and become unfit for use and even dangerous as a cargo. Prior to the erection of these plants, a load of maize being shipped to Europe had to be unloaded at Durban, South

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[13] Bromhead, W. S. "What's What in Kenya Highlands," p. 60.

Africa, because of spontaneous combustion in the hold.

THE MIXED-FARMING AREA

The southwestern part of the Highlands and the western slopes produce a variety of crops. Those listed in 1927, by the Agricultural Department of Kenya, were as follows: coffee, 13,700 acres; maize, 12,000 acres; sugar cane, 5,830 acres; tea, 2,430 acres; and wheat, 1,400 acres. Fruits, vegetables, and other crops are grown on a smaller scale.

The tea is grown at altitudes of 6,000 to 7,000 feet where the precipitation is heaviest and the humidity greatest. It is quite impossible, however, to rely upon the uncertain rainfall for tea cultivation. As a result the planter usually depends upon some artificial method of supplying moisture.

The problem of securing labor for the tea plantations is the chief difficulty to the expansion of the industry. The labor must be permanent as the plucking and manufacture of tea is continuous, which is not the case with coffee (Fig. 17).

The Highlands are well suited to the cultivation of sugar cane. There are two planting seasons each year; consequently, it is possible to have cane ready for the mill during the entire twelve months. The deep mud, however, makes it difficult to haul the cane from the fields during the rains and as a result most of the cane is harvested during the dry seasons.

THE PASTORAL ZONE

The Great Rift Valley and the drier parts of the adjoining Highlands constitute the pastoral zone of the alienated lands. Most of the trained oxen are found in the cereal belt and the mixed-farming areas. Approximately 80 per cent of the cattle, other than the trained oxen, and 95 per cent of the sheep of Kenya are raised in this area (Fig. 7), representing a striking concentration of the animal industry within that part of the Highlands which has a rainfall of less than 40 inches.

ECONOMIC ADJUSTMENTS IN BAVARIA[1]

Hubert A. Bauer
Associate in Geography, University of Washington

THE complexity of Germany's economic structure is in no small part due to the great diversity in the environmental elements which characterize the various political units of the German Republic. Among these units Bavaria, the southernmost of the German states, holds in more than one respect a singular position. Contrasts between north and south, although existing in many countries, seem to be accentuated in the case of Germany.

To the casual observer these contrasts might seem to be merely reflections of obvious physiographic and climatic differences, or again, they may appear to be caused by differences in soil, mineral resources, or location. These environmental factors are all active, but in Bavaria the type of population and the historical development are essentially different from those of the rest of Germany. An economic survey of Bavaria must, therefore, involve some consideration of the social and historical facts—indeed, some of its economic features would scarcely be intelligible unless traced back to their very beginnings in the dawn of European history.

While a general economic geography of Bavaria would seem to be chiefly concerned with a "horizontal" survey of the country, one must emphasize the "vertical" component in order to analyze and evaluate the position and significance of economic Bavaria as an integral part of economic Germany. However, this does not mean to take Bavaria out of the frame into which racial ties, recent history, and economic dependence have placed it. It would be a rather problematic piece of economic research if the general viewpoint of economic-geographic harmony, which controls any complex economic body of the nature and size of Germany, were to be omitted, for Bavaria represents a vital member of that body. That its economic branches have been able to spread and intergrow with those of the rest of Germany and of neighboring countries is largely due to the sound root-system which anchors it to a native vigorous soil.

Environmental Considerations

Bavaria is continentally situated, Munich being about as far from Genoa as Nuremberg is from Hamburg. Its 29,000 square miles extend from the Alps in the south to the middle-German highlands in the north, from the limestone ridges of the Swabian Jura in the west to the forest-clad heights of the great eastern fault scarp known as the "Bohemian Forest." The Danube divides Bavaria roughly into a southern and a northern half. The true alpine section of the extreme south characterized by numerous northward sloping valleys sends a score of turbulent rivers towards the Danube across the Swabian-Bavarian Plateau, which adjoins the alpine section in a three-fold step-like arrangement. The southern third consists of the morainic undulating Alpine Foreland, a region of typical finger lakes; the middle section is a distinct belt of terminal moraines, through which the rivers have cut gorge-like valleys; where the gravel thins out, exposing the underlying triassic surface, the high water-table has caused extended marsh land, locally known as "Moos," most of which is cultivated today. The third step is formed by a broad hilly belt of triassic age, merging at the north into the valley of the Danube, the bed of which follows the broken rim of the down-sunken old-land block of the Vindelican Mountains.

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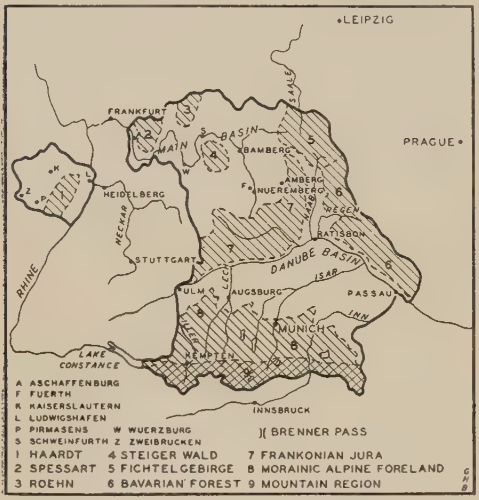
[1] The author is indebted to the "Industrie- und Handelskammer" in Munich, Nuremberg, Ratisbon, and Wuerzburg, to the Bavarian Statistical Office in Munich, and to the Verkehrsverein, Munich and Wuerzburg for providing valuable material.


LEIPZIG
PRAGUE
FRANKFURT
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BAMBERG
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DANUBE BASIN
ISAR
PASSAU
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MUNICH
AUGSBURG
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ILLER
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HEIDELBERG
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INNSBRUCK
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F FUERTH
K KAISERSLAUTERN
L LUDWIGSHAFEN
P PIRMASENS
W WUERZBURG
S SCHWEINFURTH
Z ZWEIBRUCKEN
)(BRENNER PASS
1 HAARDT
2 SPESSART
3 ROEHN
4 STEIGER WALD
5 FICHTELGEBIRGE
6 BAVARIAN FOREST
7 FRANKONIAN JURA
8 MORAINIC ALPINE FORELAND
9 MOUNTAIN REGION
GHB

Figure 1.—Location and physiographic divisions of Bavaria.

There is, however, great contrast between the land north of the Danube and that of southern Bavaria. Here, the Jurassic period left its traces in the slaty chalk sediments of the Franconian Jura and in the sandy plains of Middle Franconia. The sandstone heights of the Spessart and Steigerwald, the volcanic ridge of the Rhoen and the southern tip of the Thuringian Forest, the Hass-Berge—all look down on the broad lowland of the winding Main, where the Muschelkalk and the Keuper of Triassic time have weathered into fertile soil. The topography of this region is furthermore varied by the frequent occurrence of dolomite, which constitutes almost exclusively the heights of the northern part of the Franconian Jura, the "Fraenkische Alp," one of the scenic jewels of Bavarian lands.

The entire northeast bears again the stamp of mountainous environment in the wooded hills of the Bavarian Forest and its northern extension, the Fichtelgebirge.

The Rhenish Palatinate, separated from Bavaria proper by parts of Baden and Hessen, like northern Bavaria reflects the control by the middle-German highlands. Like most of middle Germany, it shows marked physiographic contrasts. The broad expanse of the Rhine lowland, with its rich cover of loess, is bordered on the west by the Haardt Mountains, known for their vineyards; the more gentle western slope is forest-clad and breaks up into the wider, agriculturally used zone of the Westrich. The entire northern part of the Palatinate is an irregular, hilly country of low fertility.

Bavaria proper has a true continental climate, more pronounced in the south with typical Foehn in spring and frequent summer hail. The climate of northern Bavaria is somewhat modified due to general lower elevation and to greater topographic diversity. The Rhenish Palatinate, however, lying within the reach of maritime winds, enjoys a decidedly milder climate, which, in favoring the cultivation of wine and tobacco, represents one of its most valuable economic assets.

HISTORICAL BACKGROUND

The greater part of these regions, both north and south of the Danube, have been in the hands of the Romans from 15 B.C. to about 450 A.D.; in fact, they constituted the Roman provinces, Noricum and Vindelicium. The American visitor, who enjoys the beauty of Bavarian scenery from his motor car, travels the same old Roman roads over which the famous legions of Varus tramped northward to meet defeat in the wilderness of the Teutoburger Forest. Many a Bavarian city has developed from an old Roman castellum and still bears its name, such as Augsburg from Augusta Vindelicorum, Kempten from Campodunum, and Nuremberg from the chief mart of Noricum.

Roman colonists were the first to clear parts of the dense forests; Roman enterprise, skill, and ingenuity first made use of the scanty mineral resources which Bavaria possesses—coal, iron, marble, and clay. Cleared lands and the raw materials obtained from them were utilized to supply the various Roman garrisons distributed over the country.

When the Roman legions were withdrawn about 450 A.D., many colonists and artisans remained, and their descendants mingled with the invading Boji (later Bajuvari), who migrated into the region from Bohemia about 520 A.D. These Bajuvari, roundheads of true alpine stock, were a peasant people with exclusively agricultural habits, a people to whom the economic division of life into agriculture and industry—even in the most primitive sense—was entirely unknown. Thus, it was primarily due to Roman influence that

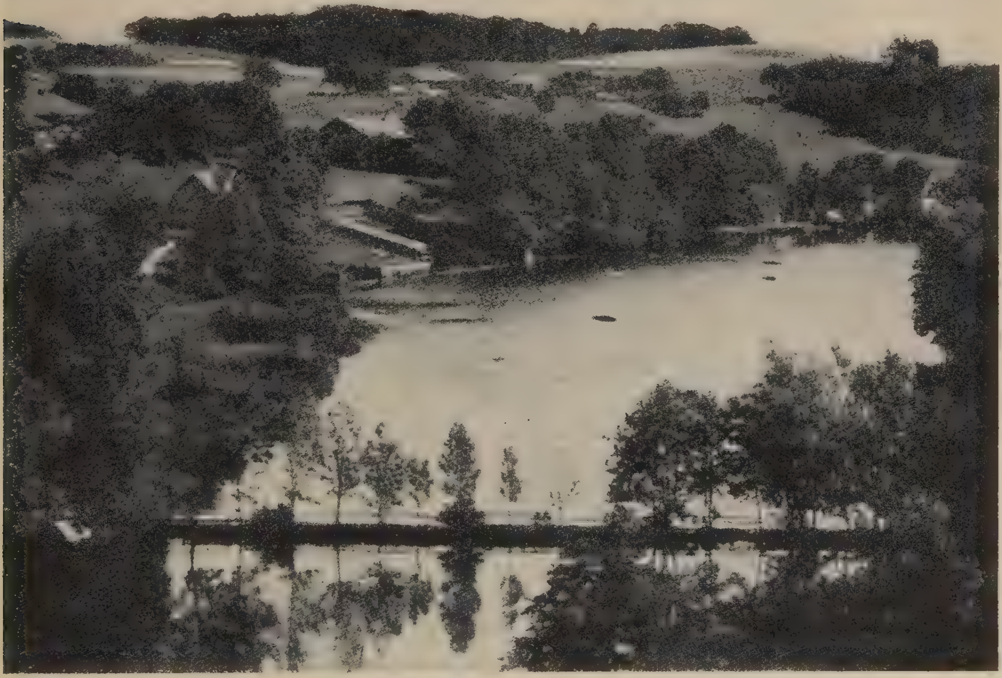
FIGURE 2.—Typical morainic landscape southeast of Munich.

some of the clumsy, though diligent, Bajuvarian farmers changed from plow to artisan's tool, a step which may be considered as the real dawn of Bavarian industry.

Further historical development was chiefly the result of the spread of Christianity with its monastic organization, which, in response to its own economic needs and its program of colonization, continued the work of clearing land, improving agricultural methods, and providing the impulses towards more intensive industrialization. The art of brewing beer from barley and hop, which is still a typical Bavarian industry of respectable size, developed in the numerous Bavarian monasteries at the time of Charlemagne. As early as 768 A.D. Bavarian chronicle mentions the "hop-gardens" (*humularia*) of Freising near Munich.

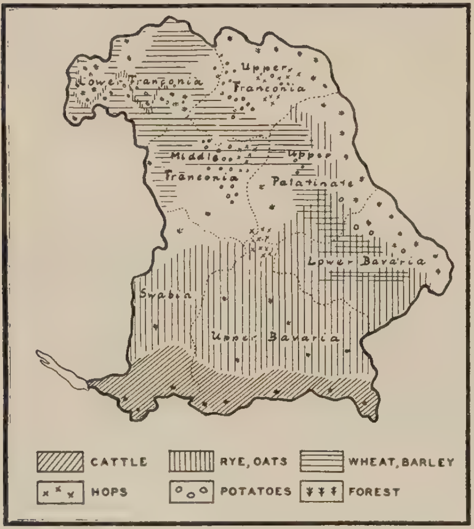

FIGURE 3.—Agricultural regions of Bavaria.

A second stimulus was provided by the crusades after the year 1000. The crusades meant orientation and economic expansion towards the east, a thing greatly favored by the eastward course of the Danube. Goods from the Orient began to flow in, new contacts were made, new trades and arts were brought home from a successful crusade and, last but not least, the oriental method of trading with money was introduced. Cities like Ratisbon at the north bend of the Danube, or Passau, the frontier town, developed as centers of artisan trade due to their favorable location on this new east-west route, the Danube. Upon the growth of Venice and Genoa this east-west trade route lost some of its importance, for these city republics offered a faster water route to the Orient, a route of greater safety and one richer in new markets. Hence in the course of the thirteenth century a new north-south trade route was opened which in following the broad valley of the Inn led over the Brenner Pass and down the sunny valleys of the Eisack and Etsch to the prosperous world ports of the Adriatic and the Mediterranean Sea. These new contacts in turn gave rise to many new industries imported from Italy with its higher stage of industrial development. At that time the important art of manufacturing paper found its way to Bavaria, and in 1320 the first cotton bale came over the Alps to Ulm and Augsburg, bringing in its wake a new era of industrial progress. The ensuing rise of the Bavarian textile industry (chiefly linen and cotton mixed) approached modern capitalistic form even in the sixteenth century, when the family Fugger in Augsburg was known as the wealthiest patrician house in all Europe, lending money to kings and emperors. That other cities, particularly Nuremberg, also shared in this wave of prosperity may be inferred from a statement made by Pope Pius II that "the citizens of

Nuremberg live better than the kings of Scotland." This was a time when nearly every trade was ruled by strong artistic taste, when the artisan was an artist, when the masters of the trades constituted the prime of citizenship, often influential political leaders.

Between this first climax in Bavaria's economic history and the present day occurred, however, a long period of standstill and complete stagnation. The cause was again a shifting of trade-routes, this time the opening of oversea routes subsequent to the discovery of the Americas, and of the new sea route to India. Furthermore, the thirty years' war and other religious struggles like the Hussite invasions devastated Bavaria so completely that even the inland market was ruined for many years. Then came a short period of recovery followed by a second economic relapse, the result of the Napoleonic wars at the end of the eighteenth century.

Conservative by nature and severely handicapped by the antiquated guild-system, Bavarian industry was slow to introduce the mechanical processes which followed the invention of the steam engine. Relatively late (1837) the first mechanical weaving loom was installed; in 1835 the first experimental railway was built between Nuremberg and Fuerth, but other lines followed then in rapid succession. This marked not only the beginning of the new era of industrialization, but also a closer trade-contact with the rest of Germany, new markets for Bavaria's surplus and a more accessible supply of much-needed raw materials and mineral fuel.

This period should also be associated with three outstanding rulers, King Ludwig I, Maximilian II, and Ludwig II, all of which immortalized their love of art and science in a surprising number of beautiful structures, of valuable collections, and of scientific institutions, thus promoting the natural artistic leaning of the Bavarians and stimulating a series of subsequent industries, which otherwise would never have developed to such proportions as they did.

Bavaria's admission as a federal state into the German empire in 1871, an event which crowned Bismarck's work, was of great economic significance, for it linked Bavaria to the world markets. As a member of the German empire, Bavaria, in contrast to other members, succeeded in reserving various privileges, the most important of which was state-independence of railroads and mail. With southern pride and inherited stubbornness Bavaria anxiously watched and fought for the continuance of these reservations; for behind pride and stubbornness were strong economic reasons, which controlled this "particularism" of the southern confederate.

This brief historical outline may serve to explain in part those economic adjustments in Bavaria, for which environmental causes seem to be inadequate.

ADJUSTMENT TO SOIL

The outstanding economic adjustment in Bavaria is to soil. Agriculture has been the backbone of Bavaria's economic life ever since the first Bajuvarian farmer turned the first sod with primitive plow. The predominance of agricultural adjustment is not only reflected in the number of people engaged in agricultural pursuits; it is also shown

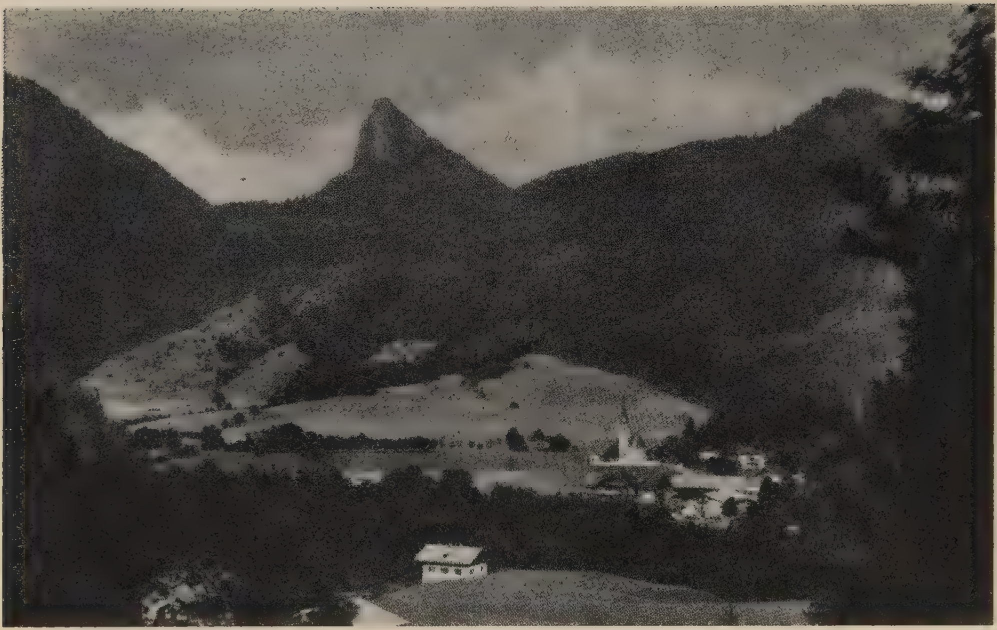

FIGURE 4.—Alpine Forest and Dairy Region, Dorf Kreuth, near Tegernsee.

in a relatively large contribution to Germany's food supply, which approximates 25 per cent. Bavaria's share in Germany's total agricultural production was in 1925 as follows:[2]

	Per Cent
Wheat	6.4
Rye	9.2
Barley and oats	17.5
Potatoes	11.8
Hops	81.3
Wine	27.7
Dairy products Beef cattle	20.7

The areal distribution of these products as exhibited by Figure 3 follows, of course, closely the qualitative distribution of soil.

AGRICULTURAL CROPS

The stock raising and dairy industry is concentrated in the Mountain Region and the Alpine Foreland, where as in Switzerland and the French Alps an intensive use of the summer-pastures of the "alp" is made. The cattle and dairy farmers of the mountain valleys coöperate successfully in so-called "Weidegenossenschaften" (pasture-associations). The alluvial plain of the eastern Danube, comprising most of Lower Bavaria with some loessal soils, is called the "Kornkammer" (grain-chamber) of Bavaria; this region is a pronounced surplus district for wheat and barley. Oats and rye, crops which are especially adapted to Bavaria's harsh continental climate, are practically grown in all agricultural regions for local needs. The same is true for potatoes, but the sandy soils of Middle and Lower Franconia produce the largest quantities and the best qualities. Hops, an important product in a country where beer is considered a valuable contribution to food supply and where brewing is, therefore, a tradition, is restricted to smaller areas of rich soil, such as found near Ingolstadt on the Danube and about Spalt and Erlangen, regions also noted for tobacco. Nuremberg and Bamberg are the outstanding centers of the hop-trade. Wine is the money crop along the course of the lower Main, chiefly grown on the southern slopes between Schweinfurth and Wuerzburg in Lower Franconia, where the terraced landscape is not unlike that of the Rhine and the Moselle. Another noted wine region is the eastern escarpment of the Haardt in Rhenish Palatinate; second to wine is tobacco in this latter region; early tobacco-growing has given rise to an important tobacco-working industry, which has long since outgrown the local supply depending to a large part upon the better qualities of oversea tobacco.

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[2] Dr. Fr. Zahn, *Bayern und die Reichseinheit.* 2. Aufl., Muenchen, 1925.

DAIRYING

Outstanding in quantity and quality among agricultural commodities are the dairy products of the Alpine Region, especially those from the southwestern part known as the "Allgau." Allgau cheese and butter are scarcely inferior to the neighboring Swiss products although not so widely known. Coöperative organization similar to that in Denmark is largely responsible for the economic success of this dairy region. The cheese and butter exchange in Kempten controls the entire Bavarian market. Fresh milk is shipped from the Allgau as far as Nuremberg. It is economically significant that the same region is also noted for its manufacture of parchment paper as used for wrapping butter and cheese. The value of dairy production amounted in 1924 to 29.5 million dollars as compared to the combined production of bread grain (wheat, barley, rye), which in the same year was valued at 71.5 million dollars.

Agricultural Organization

In contrast to northeast Germany, Bavaria is a country of small farmers. Bavarian agriculture is characterized by a great predominance of homestead farming; the family-owned farm, the "Bauerngut," handed from father to son, is the rule. As much as 94.5 per cent of all agricultural land is owned by the farmers, and two-thirds of all farms are homesteads.

Of the total of 666,000 farms, over one-half are small farms (1 to 12 acres); over one-third are middle-sized farms (13 to 50 acres); about one-twentieth are larger-sized farms (51 to 250 acres); and only 548 farms are holdings over 250 acres. The middle-sized farm forms the backbone of agricultural life in Bavaria. This size of farm is associated with that special type of hereditary farmer who determines the social and political particularity of the country. Rooted to the soil, loyal, hardworking, healthy, simple, and conservative in his habits, he is nevertheless friendly to progress. This is also true in some measure of the holders of smaller and larger farms.

Due to the abundance and early development of waterpower in southern Bavaria, practically all farms enjoy the advantage of electric light and to a lesser extent of power. The modern need for coöperative organization is widely recognized and appreciated. This type of organization included in 1927:[3]

1,004	Productive Associations (including sale)
549	Work Associations (chiefly for plowing and threshing)
103	Cattle Breeding Associations
190	Buying Associations (seeds and fertilizer)

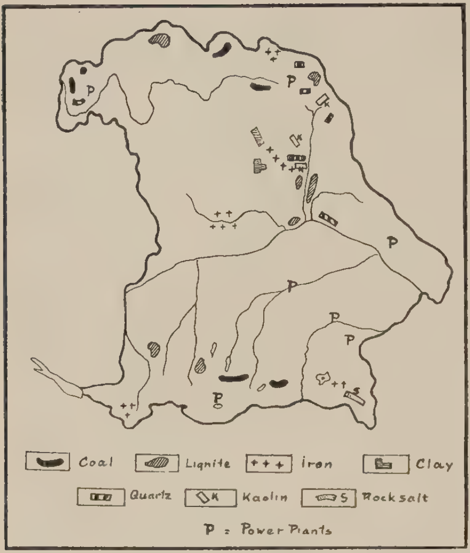

FIGURE 5.—Mineral resources and water power in Bavaria.

108 Warehouse Associations
4,920 Credit Associations

Most of these coöperative associations are organized in seven central bodies, "Zentralgenossenschaften," who represent a factor of great power in the economic and political life of the country.

Government Aid to Agriculture

The government, in which the farmers are well represented, spends annually considerable sums (in 1926 some 8 million dollars) for the advancement of agriculture, by operating the following institutions:[3]

1 Agricultural College (connected with brewery-school)
1 Forestry Academy
1 Veterinary College
88 Agricultural Schools
17 Agricultural Household Schools for Women
4 Schools for Garden Fruit- and Wine-Culture
3 Seminars for Agricultural Teachers
98 Agricultural Service- and Advice-Stations
1 Chemical Institute for Soil Analysis and Soil Improvement
1 Biological Institute for Fish Culture
A System of Winter- and Travel-Schools
A System of Offices for Soil Culture
Several model farms
An experiment station for moorland cultivation

These state institutions are supplemented by numerous private organizations, especially such concerned with the raising of small animals like fowl, goats, and sheep, or with vegetable-, fruit- and bee-culture.

FORESTRY

The importance of Bavaria as a wood grower is best shown by a comparison with the British Isles, where the proportion of wood area to population is somewhat less than 8 acres to every 100 persons. The Bavarian proportion is 95 acres to every 100 persons, considerably exceeding the ratio for self-supply which is estimated to be 85 acres to every 100 persons.[4]

Bavaria has a total forested area of 7 million acres, of which 2½ million acres are state forests; 1¼ million acres are community-owned forests; and 3¼ million acres are private forests. That these 3¼ million acres of private forests are owned by farmers, not by private capital, is of great economic importance to all parties concerned: the farmers, the country, and the forests.

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[3] *Statistisches Jahrbuch fuer den Freistaat Bayern, 1928.* Published by the "Bayerisches Statistisches Landesamt," Muenchen, 1928.

[4] Lyde, Lionel W., *The Continent of Europe.* Macmillan & Co., Ltd., London, 1926.

The areal distribution and the types of forests reflect closely topography and soil. That the names of many Bavarian hill regions are ending in "wald" (= forest) is not only suggestive to a former heavy timber-cover of these regions, the names continue to be appropriate also at the present time, thanks to wise use and systematic reforestation.

A heavy stand of fir and pine covers the north slopes of the Bavarian Alps, but the timberline extends hardly beyond 5,000 feet. The morainic Alpine Foreland has a more park-like growth of conifers, largely owned by farmers and communities; the more extended forests of this region are state-owned, well kept, continuously reforested, and are housing considerable numbers of game. The river courses are fringed with that typical mixture of conifers and leaf trees (beech) which render the riverine land so colorful in spring and fall. Birch is the tree characteristic to the marshy stretches fringing the outwash plain, while thin stands of scotch fir are the only forests thriving upon the sandy soils of middle Franconia, especially around Nuremberg. Beech and oak, with the former prevailing, cover parts of the Franconian Jura, stand and quality increasing towards the north, but both comparatively poor due to the quick loss of moisture in the porous chalk. One of the largest uninterrupted areas of dense forests (fir and pine) is represented by the Bavarian Forest and the Fichtelgebirge, the latter name revealing the predominant species (Fichte = pine). Upper Franconia, which includes the Fichtelgebirge and the Frankenwald to the west of it, boasts not only of the most beautiful beech-woods in Bavaria, but also of the highest percentage of forest-area 35.5 per cent as compared with 40.8 per cent of agriculturally used land. Another veritable green sea of chiefly deciduous forests present the Steigerwald and the Spessart, the latter famous for the best quality of commercial timber, including a heavy stand of oak. Strikingly bare of forests are the heights along the middle course of the Main, where wine is grown, and the volcanic soils of the Rhoen to the north of it, a reason that the latter has become the most popular training field for German "gliders."

Closely associated with forestry in Bavaria is the protection and keeping of game. The economic importance of this phase of forestry may best be shown by some figures taken from the statistical yearbook of the Freestate Bavaria for 1928. The total number of game killed by licensed hunters during the year 1928 amounted to 459,369, including stag, deer, hare, wild boar, and chamois, also 250,447 wild fowl, and 72,111 predatory animals, altogether valued at about one million dollars.

In reviewing Bavaria's adjustment to soil it may well be said that the country is making intensive use of its relatively poor soils and unfavorable topography. Three factors appear to be responsible for the high standard of agriculture (including dairy farming and forestry): a sturdy and diligent type of hereditary farmer, the intensive use of high-grade and cheap fertilizer, and the aid and wise guidance by an agriculturally minded government. The shortage in certain products like in wheat, barley, rye, and swine is almost balanced by a considerable surplus in other products of the soil, such as oats, hops, potatoes, beets, hay, straw, dairy and forest products, and beef-cattle.

INDUSTRIAL ADJUSTMENTS

Bavarian industries, though most of them are small when compared with the gigantic industrial centers of the Rhine and Ruhr or with those of Saxony, are by no means negligible. Some of them have increased in size and have become indispensable pillars in the huge structure of Germany's industrial life, thus contributing their modest share to the world's needs. Bavarian statistics reveal surprising numbers of industrial plants of almost every description and size; the whole country, small as it is, buzzes with a very diversified industrial activity. It is this diversity in industrial adjustments which requires careful analysis, in order that the soundness of Bavaria's industrial life may be justly appraised and clearly understood.

FIGURE 6.—Products of Selb, the city of porcelain.

As in most countries of the old world, a great number of industries had their beginnings in the artisan's workshop, and their development was primarily due to the spirit of enterprise on the part of some skilled master. Such types of industrial development may hence be called "accidental," unless the development has been favored by one or more of the locative factors of industry. There are some fifty different classes of goods manufactured in Bavaria, and the number of different commodities runs far into the thousands. In the face of this variety of industrial activity it would appear that some attempt at an industrio-geographic analysis would be desirable. By this plan a double result should be achieved: (1) an environmental grouping of the industries; and (2) a clear comprehension of the casual interdependence of economic activity and environment, both taken in their widest sense. The headings chosen for the following paragraphs suggest the chief locating factors.

LAND UTILIZATION

With the exception of the southern pasture-lands and the various pronounced forest sections, bread grains are grown everywhere. Numerous flour mills are, therefore, distributed all over these agricultural districts, ranging from the modest old type mill, sufficient for local needs, to the gigantic modern milling plant supplying the populous urban centers. The latter type, though originally located in the south with its rich water-power sources is, however, now to be found wherever the need for them has arisen, for electric power has recently been transmitted over the whole country.

The still important, though declining, brewing industry follows the distribution of hops and barley, a correlation which is indicated by the famous beer brands of Munich, Nuremberg, and Kulmbach. In the case of Munich beer it is interesting to note that the quality of the water and even that of the atmosphere plays a part, since scientific tests have proved that equal aroma and flavor cannot be obtained in any other locality. Associated with beer production is that of malt and malt-products, also the manufacture of brewing machines with Munich as the chief center. Munich and Nuremberg, lying as they do adjacent to important agricultural areas are the natural centers for the manufacture of agricultural machines and implements.

In response to the abundance of forests there are about 1,500 sawmills throughout Bavaria, chiefly in the south, in the Bavarian Forest and in the Spessart region, where the most valuable timber is obtained. The same regional distribution holds true for the paper industry. In the south, due to greater water-power resources, there is a numerical predominance of paper mills, although the largest plant is that at Aschaffenburg, the Main-city controlling the Spessart region.

As has been mentioned under "adjustment to soil," most of the agricultural land of southern Bavaria is in pasture, thus giving way to a well-concentrated stock-raising and dairy industry, the former all over Upper Bavaria and Swabia, the latter attaining its most intensive development in the southern part of Swabia towards Lake Constance.

MINERALS

Many writers refer to Bavaria as a country noted for its *entire* lack of coal and other minerals. It may then be surprising that Bavarian statistics for the year 1927 show 4 anthracite mines, 25 bituminous and lignite coal mines, and 76 iron-ore mines, with a total employment of 8,633 miners and an output of almost 3 million tons (valued at $7,000,000). The mineral *wealth* is almost entirely confined to the Upper Palatinate[5] and to Upper Franconia, some coal and rock-salt occurring, however, in small quantities along the piedmont of Upper Bavaria. Iron is of some importance at Amberg where blast-furnaces are in operation. The Upper Palatinate and Upper Franconia, lying along the fracture of the old crystalline core, are rich in granites and basalts, in feldspar, quartz, marble, and slate; also, in kaolin and clays. The porcelain industry of this region includes some 50 plants, some of them employing as many as 2,500 workers. Selb, the "porcelain city," is the home of the famous "Rosenthal" brand, noted for its artistic design and shipped all over the world. The manufacture of glass is also localized in the northeast, particularly in the Fichtelgebirge, but also in parts of the Bavarian Forest and of the Spessart. The industry employs about 15,000 workers and supports more than 100 establishments in Nuremberg and Fuerth, cities which specialize in plate glass, mirrors, and other finished glass wares.

How old the glass industry in these quiet forest-valleys is, and what share history has had in the economic development of the region, is well illustrated by the glass-pearl industry of the Fichtelgebirge. Protoberas, a dark green mineral of the "hornblende" group, attracted the primitive glassmakers at an early period by its superior fusibility and its fitness for the manufacture of glass beads. These pearls, as they were called, became so much in demand as barter articles or economic tokens, that during the time of the Crusades they spread over the Balkan countries into Asia Minor and even to

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[5] Sometimes called the "Steinpfalz" (Stein = rock, pfalz = Palatinate) in phonetic imitation of "Rheinpfalz" (Rhenish Palatinate).

Persia. When the trade route over the Brenner opened, the Fichtelberger beads flowed into Africa by way of Venice and Genoa, and it may well be assumed that Columbus carried them on the Santa Maria into the West Indies. Today they are found in the necklace of many a South Sea beauty as well as in the rosaries of pious Mexican nuns—a unique fact of economic geography. At the present time glass pearls continue to be a specialty of the region, and the industry is still leading its fairy existence in the dreamy valleys of the Fichtel. Its only change has been the adjustment to the demands of an ever-changing style on the world markets through the application of the inherited skill and diligence of its thousands of home workers to a greater variety of products.

The Franconian Jura as a limestone formation is noted for its numerous lime-furnaces, as well as for its quarries of lithographic plates near Solenhofen, a place well known to the paleontologist for its abundance of Jurassic fossils. Brick yards, numbering over 500, are widely distributed, but most numerous in the vicinity of Munich, which furnishes a large consuming market. The pottery and chamotte works are chiefly located in the Upper Palatinate (around Schwandorf) and near Coburg in the extreme north.

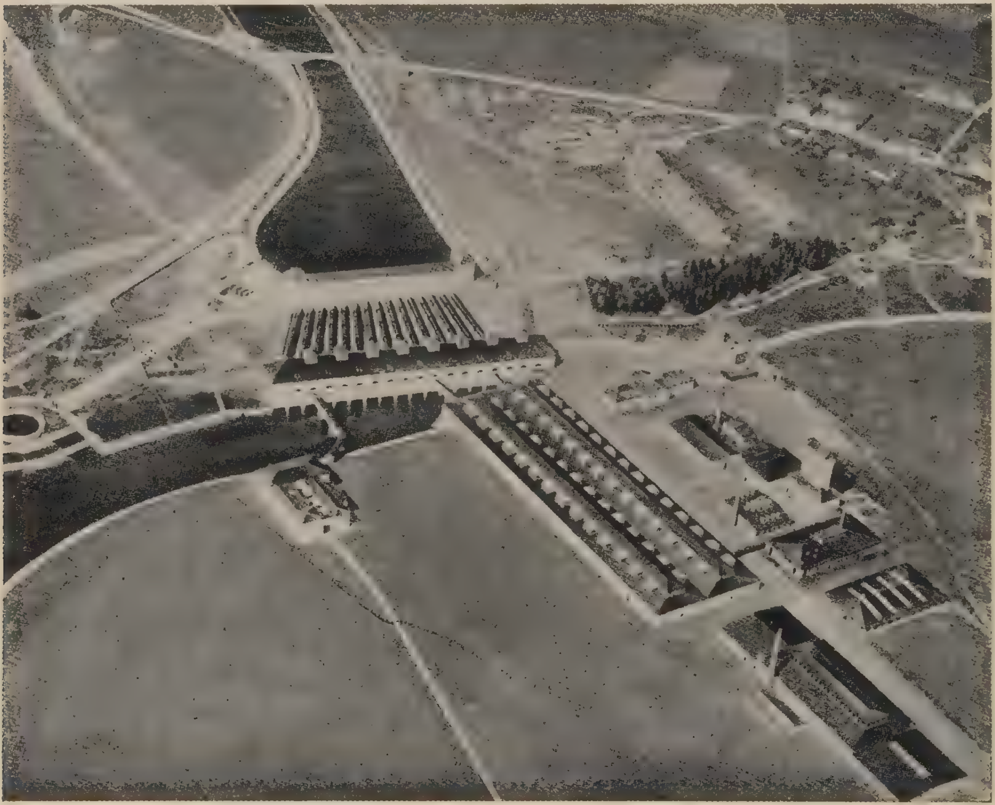

FIGURE 7.—The "Innwerk" near Muehldorf on the Inn. Power and Aluminum Plant.

Lyde, the British geographer, ascribes the location of the important lead pencil industry of Nuremberg to the occurrence of graphite near Passau. These graphite deposits are, however, insignificant in quantity and of a quality which would hardly justify the world reputation of Nuremberg pencils. The graphite deposits, from which the Faber factories draw their supply, are located in the cellars of the Faber plants. Many hundreds of tons of this unexcelled graphite have been mined in Siberia some fifty years ago by Lothar von Faber and brought to Nuremberg, a supply which is estimated to last at least another hundred years.

WATER POWER

The development of water power is the most recent chapter in the economic history of Bavaria, and the chapter of greatest importance. The process of power generation itself concerns only a comparatively small number of persons (8,000 at the present time), but the new industrial revolution, brought about by the post-war establishment of huge power projects, affects practically the whole economic life of the country. The manufacture of electric materials, the installation of power service, and other subsequent lines of activity have increased on a scale hardly equalled by any other country of this size. Existing industries have expanded, and a great number of new industries have sprung up in regions which never dreamed of such industrial possibilities.

The numerous mountain lakes and the rapidly flowing rivers of the Alpine Foreland represent a potential power of over 2 million H.P. of which 939,000 are already developed. While thousands of small plants created by private or communal enterprise had already existed before the war, the last decade has been so marked by the development of a series of well-planned state projects, that the electrification of Bavaria is rapidly becoming a reality. Bavaria's developed water power is distributed as follows:[6]

Horse Power	*South Bavaria*	*North Bavaria*	*Total Horse Power*
Under 150	Approximately	11,700	173,000
Over 150	130	70	766,000
Over 1,500	38	10	635,000
Over 10,000	11	..	590,000

These power plants serve the following industries and purposes:

Purpose	*No. of Plants*	*Horse Power*	*Per Cent*
Electric light and railroads	969	533,000	56.7
Electro-metallurgical and chemical	8	185,000	19.7
Saw mills, flour mills, farms	8,197	105,000	11.1
Paper mills and associated industries	146	38,000	4.1
Textile industry	134	37,000	4.0
Not classified (workshops)	2,487	42,000	4.4

This table shows clearly that water power is the chief locating factor for the metallurgical, chemical, and textile industry. A comparison of the different industrial groups which use water power reveals the enormous consumption of electrical energy in metallurgical and chemical plants. A single plant of that group, the aluminum works of Toeging on the Inn (Fig. 7) consumes one-half of the 100,000 H.P. produced by its power plant, the "Innwerk," while the other half serves a variety of purposes. The output of the plant in aluminum amounts at the present time to 12,000 tons annually. Another important industrial plant at Tacherting, built upon the water power of the Alz, a tributary of the Inn, uses the entire energy of its 40,000 H.P. for the manufacture of more than 30 important chemical compounds. These are but a few selected examples which illustrate the rise of new industries in an otherwise industrially poor region.

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[6] Huebschmann, K., "Die Entwickelung der Wasserkraftausnuetzung in Bayern," Article in Kuhlo "Geschichte der bayerischen Industrie," Munich, 1926.

The cotton textile industry has, of course, always been located by cheap power, and cotton spinning is, therefore, to be found in many mountain valleys of southern Bavaria, especially in Swabia (Fig. 8), where Augsburg, Kempten, and Sonthofen are the chief centers. The north-Bavarian textile industry, also chiefly cotton, is only in part located by water power; in many cases there are other nearby sources of energy, such as the lignite deposits of Czechoslovakia and Saxony, responsible for the development which followed the industrial revolution around the middle of the nineteenth century. The chief spinning centers of northern Bavaria are Nuremberg, Fuerth, Bamberg, Hof, Kulmbach, Forchheim, and a great many still smaller places, some of which specialize in products of the so-called "leonic" industry, the spinning of gold and silver threads and laces. Both textile centers, the Swabian and the Franconian, represent a total of over two million spindles.

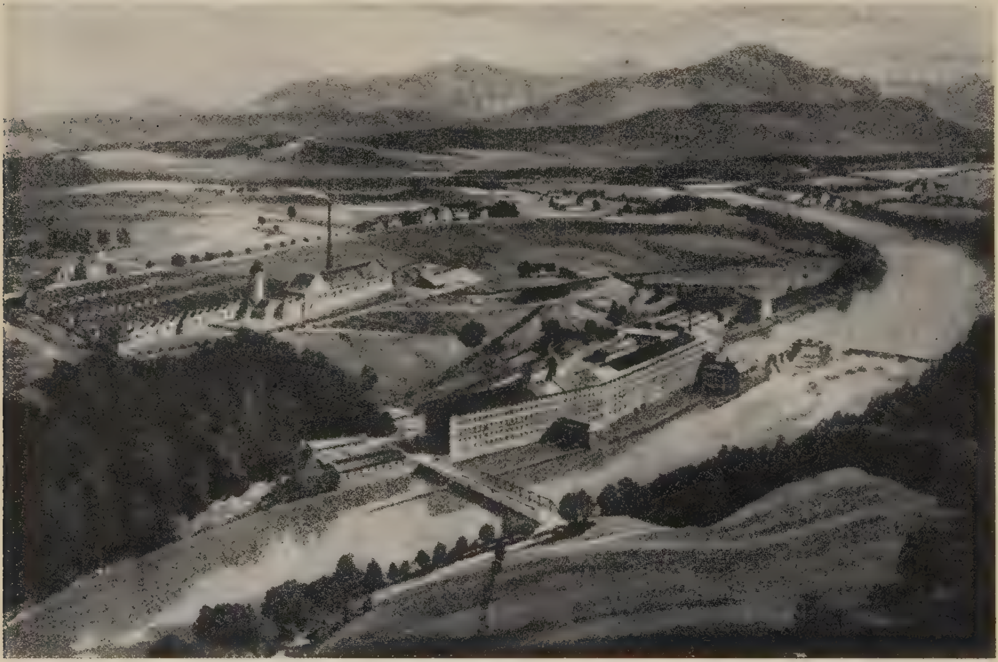

FIGURE 8.—Cotton spinning plants in the Allgau.

CHEAP LABOR

Cheap labor is in many cases a result of dense population. Again, it may in some cases be associated with less dense population but poor soil, though the latter association is far from being an economic law, as the example of the Po basin—good land and cheap labor—shows. Yet, in Bavaria, where the population density is somewhat less than 250 per square mile as compared with almost 350 for the "Reich," there are distinct regions, where poor soil is undoubtedly the chief locating factor for typical industries of the cheap-labor kind. The toy industry of northern Bavaria with Nuremberg as collecting center is one of them. Toys are made in the poor valleys of the Fichtelgebirge and around Coburg. The latter region specializes also in basket weaving; not less than 2,731 small concerns who manufacture wicker ware live in the towns and villages around Lichtenfels and Coburg.

Another region of poor soil is the Spessart. Aschaffenburg, the chief city in that region, has developed an enormous clothing industry; 40 factories keep a score of tailor-villages busy in the adjacent valleys of the Spessart and the Odenwald, where 7,000 people working in self-organized village groups enjoy a fairly prosperous though busy existence. Though the origin of this clothing industry must be classified as accidental, its development to the present state was decidedly favored by a rural population living on poor soil.

On the other hand, Bavaria also offers an excellent illustration for the existence of a cheap-labor home industry in a prosperous dairy region. The town and district of Lindenberg in the Allgau near Lake Constance is known for its straw hat industry, which is of more than one hundred years' standing. Old records of the region show that as early as 1815, at the close of the Napoleonic wars, 356 families were engaged in straw hat manufacture, the output of that particular year amounting to about 56,000 hats. The wheat-straw used was imported from Italy or supplied by the Black Forest region. The nearness of sunny Italy was certainly one of the primary impulses which started this home industry. The increasing mechanization of the manufacturing process, the invention of the sewing machine and of the hydraulic press brought a change in factory methods. Bleaching and dyeing plants sprang up as auxiliaries; leather, hat-band, and lining factories followed; and finally, a cardboard-plant was added to supply the containers for shipping the finished product of this well-organized industry. One should expect, then, that the original home industry was entirely replaced by these modern factory methods; more so since the Allgau had, toward the end of the last century, developed into a prosperous dairy region; but, up to the present day, a small army of nearly 4,000 women and girls still takes care of the sewing and outfitting as in the household stage of the past. The industry was highly stimulated by the acquisition of Kiaochow by Germany in 1896. This meant a direct and therefore cheaper supply of Chinese straw braid, a commodity which had replaced the European supply but had, up to that time, been exclusively controlled by the London market.

PERPETUATED SKILL AND ART

Industrial occupations a hundred and more years old, such as the glass industry, the toy-making industry, the basket weaving of northern Bavaria, or the sheet-gold industry of Fuerth, may, of course, be attributed to the influence of inherited skill as a locating factor, although their origin was certainly due to other causes. The people of the old Bavarian stock, living as they do in the seclusion of their mountain valleys of Upper Bavaria, show an even greater disposition for inheritance of certain gifts, such as a marked leaning towards art in many forms. Music, wood-carving, and folk-play are the most outstanding of these artistic traits. Some of these rural crafts, but not all of them by any means, have acquired a volume which almost justifies the use of the word "industry," though in a modest sense.

Of outstanding importance is Mittenwald, the town of violin makers and wood-carvers at the foot of the Karwendel, a town of scarcely 1,000 inhabitants. The art of violin making came to Mittenwald from Italy[7] as early as 1653 and persisted there as a tradition. Although the industry is declining, there are still some 250 violin makers in Mittenwald, who continue to operate their modest workshops without ceasing to be fairly prosperous livestock farmers at the same time.

Other villages in the Bavarian Alps, such as Garmisch at the foot of Germany's highest peak, the Zugspitze, specialize in wood carving; in addition Garmisch is a famous winter resort. Still better known is Oberammergau, which enjoys a world reputation with its "Passion Play." This little place developed its traditional play to such an extent that it has long been the mecca of tourists, drawing some 100,000 visitors every ten years. Although not an industry, this is an adjustment of rare kind, an adjustment which is also undoubtedly economic when measured on the modest scale of these simple mountaineers.

The very important art products industry of Munich is another economic adjustment to the artistic atmosphere of Bavaria, particularly to that of its capital city (Munich) with its wealth of art collections, old castles, and famous churches. This industry includes the hundreds of large and small factories and workshops for metal, wood, and ceramic work; it includes also an extended graphic industry with 780 printing establishments and lithographic studios.

FIGURE 9.—Alpine Pasture. The highest German peak, the "Zugspitze" (10,600 feet) in the background.

SCIENCE

A locating factor, science, may appear unusual; and yet, it is chiefly the early development of Bavarian universities and "Technische Hochschulen" which together with their high standard of scientific research is responsible for the large number of plants concerned with the manufacture of scientific instruments. Instruments of precision mechanics, optical goods, medical instruments, and surgical equipment are Bavarian specialties. The names of Frauenhofer (optician), Steinheil (telephone), Roentgen and Linde (physicists), Liebig and Bayer (chemists) are intimately associated with this type of economic adjustment. That Bavaria boasts of the largest chemical plant of the world, the "Badische Anilin and Soda Fabrik" in Ludwigshafen on the Rhine (Rhenish Palatinate), is not a pure Bavarian achievement, since it is more accidentally that this huge plant was transferred from Mannheim to its present location. Bavaria proper has a few hundred chemical plants which manufacture chemical products of the widest range, especially dyes, paints, and fertilizers; Heufeld near Munich is one of the large war-grown nitrogen plants so important to German agriculture.

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[7] Mittenwald is located at the northern end of Seefeld Pass which is the shortest approach to the Brenner Pass.

POLITICS

Even after its entrance into the German empire of 1871, Bavaria retained, in contrast to the rest of German federal states, a few special privileges, one of them being the authority to operate her own railways. This state independence in fighting the centralization principle of Berlin stimulated an important industry which had developed in Munich, the manufacture of locomotives and of railroad cars with a score of subsequent plants, of which two factories for roller-bearings in Schweinfurth are of particular importance. The two large locomotive plants in Munich employ from 2,000 to 3,000 workmen.

It was but a step from the manufacture of locomotives to the making of machinery of any kind, and consequently there developed a large Bavarian machine industry, which has in recent years assumed the lead in Germany. The "Maschinenfabrik Augsburg-Nürnberg" holds a world reputation for gas-engines, especially for diesel motors: most of the diesels for the war-submarines were manufactured in its plants.

RELIGION

The devotedness of a large part of the Bavarian people to the Catholic creed is so pronounced that religion must be considered as a locating factor for at least a few of Bavarian industries. For example, the wholesale use of wax candles in the Catholic church requires a veritable army of wax manufacturers. The "Wachszieher" is one of the traditional trades found in almost every Bavarian town. The making of stained glass for church windows, the manufacture of church utensils for the ritual of Catholic church service, and finally the exclusive printing establishments for religious art constitute in fact, a regular "catholic industry."

The "Passion Play" at Oberammergau which brings such tourist wealth to Bavaria is in itself a testimony to the reality of religion as a factor in the national life. In no country save Bavaria would such a super-drama even be possible.

SCENERY

Bavaria is noted for its scenic beauty, and, unlike other tourist countries, it offers satisfaction to the most diverse tastes. It combines the romantic beauty of Swiss alpine scenery with the subtle charm of the English Lake District, the quaint arcaded streets of Italian towns with the broad boulevards of modern cities, the art of Paris, Copenhagen, or Dresden with the bustle of the Ruhr, the medicinal springs of a Carlsbad with the snow of a Norwegian winter.

Bavarian scenery, Bavarian art, and—perhaps—Bavarian beer are the elements of the country's attractiveness and hence the locating factors for its tourist industry. In 1927 the hotels and hostelries in cities and rural resorts reported a total patronage of nearly 4 million visitors, a figure which may serve better than anything else to indicate the economic value of this important industry. The Alpine Foreland, especially Munich as the physical and intellectual focus of the tourist trade, has undoubtedly made the closest adjustment to this environmental factor, while northern Bavaria with Old Nuremberg, the medieval Rothenburg, and the Wagner-city, Bayreuth, heading the list, is second.

LOCATION AND IMPORTANCE OF URBAN CENTERS

As in many other countries there is also in Bavaria a slow but steady increase of urban population as compared with that of the rural districts. Classifying places with a population over 2,000 as "urban," the distribution of urban and rural life shows the following trend:[8]

	1910	*1925*
Rural population	3,800,179	3,816,386
Urban population	3,082,058	3,563,208
Per cent—rural population	55.2	51.7
Per cent—urban population	44.8	48.3

In spite of this apparent tendency toward urban predominance, the fair balance of the present distribution seems to reflect a likewise fair degree of economic harmony.

The few larger cities of Bavaria, representing the necessary concentrations of economic progress, indicate, by their very location and size, a sound economic development based on a well-proportioned adjustment to the natural regions which they control.

All these urban centers are old, and their origin and early development reaching back into early post-Roman time was, therefore, primarily dictated by strategic reasons. But, of the considerable number of old strongholds and strategic points, only those which came up to the requirements of economic strategy could expect to survive.

FIGURE 10.—"Neuschwanstein," one of the beauty spots of the Bavarian Alps.

Munich (the original name "Monachia" reveals it as an early monastic settlement) controlled not only the Brenner route, but also the old salt road leading from the southern rock-salt region around Salzburg to the north. Located, besides, on the "Isara rapida," a river on which raft-floating is a tradition, the city was and still is the chief gate to the southern timber region. In 1927, 2,819 timber rafts arrived in Munich. With the coming of the railroad, Munich rapidly became the economic center of the country, as well as its financial and political leader.

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[8] From "Heft 116 der Beitraege zur Statistik Bayerns." Munich, 1928.

The city houses an astonishing variety of industries, specific trades, the ever-congested condition of its central station (one of the largest units in Germany)—all bear testimony of the large commerce which passes through and radiates from Munich.

Augsburg, only one railroad hour from the capital and in a river-location very similar to that of Munich, is, in spite of its old and mighty textile and metal-working industries, a city of modest size, limited in every respect by its very nearness to the capital. Both cities reflect the Highland control: Munich the old-Bavarian part, Augsburg the Alemannian part; both cities are likewise favored by recent water-power development. The Lowland is represented by three urban centers: Ratisbon, Nuremberg, and Wuerzburg, each having a special economic function.

Ratisbon owes its economic significance almost entirely to its location at the northermost bend of the Danube. Its recent economic growth is to be associated with the extension of the Danube navigation, which made Ratisbon its western terminus. The river-commerce passing through Ratisbon's small but modern port amounted in 1927 to 529,260 weight tons, carried in some 1,500 boats of 600 to 1,000 tons capacity. The export of 278,597 tons consisted chiefly of metal wares, machinery, salt, flour, chemicals, and tanning material, while the import of 250,423 tons was made up of only three large items: Hungarian maize, Rumanian wheat, and Rumanian mineral oil.

Nuremberg's economic importance reaches far back into the Middle Ages. Its early development was favored by a typical plains-location at the junction of two important trade routes, the alpine N-S route and the E-W route from Frankfort to Ratisbon. At the present time, with a population of little more than half that of Munich, it employs (together with its sister-city Fuerth) 90,000 industrial workers, the same number as the capital. The industrialization of the Franconian metropolis is, therefore, far more advanced than that of Munich. It is again due to location that its economic radius extends into a more diversified industrial area; a considerable part of the mineral-working Upper Palatinate is controlled by Nuremberg firms, while Fuerth concentrates and works all the glass from the Bavarian Forest, the Fichtelgebirge, the Spessart, and even from Saxony. Toys and pencils are only two of the outstanding products of Nuremberg which have won world reputation; of no less importance is the manufacture of metal ware, machinery, electric supply, notions, tools, brushes, leather and rubber ware, the spinning of metal thread, and the making of sheet-gold. That beer is another specialty is only logical for a city which houses the controlling hop-exchange of Bavaria.

Wuerzburg, the University city on the Main, holds a position of minor importance in the economic life of the country. Its local industry is closely adapted to environment, to wine, and to forest; a well-developed graphic industry, the manufacture of printing presses, and of mathematical instruments reflect the academical atmosphere. Handicapped by location—it lies in a regular basin surrounded by vineyard hills—its industrial development was hindered, and the energy of its citizens turned time and again towards neighboring cities, such as Aschaffenburg, Kitzingen, or Schweinfurth, cities which are about to overshadow more and more the industrial importance of Wuerzburg.

Among the urban concentrations of Rhenish Palatinate, Ludwigshafen on the Rhine is by far the most prominent city; due to the "Badische Anilin," as Germany's largest chemical plant is called, the city holds the record in recent growth of population (22.3 per cent since 1910) among the larger Bavarian cities. An example of intensive industrial specialization is furnished by the city of Pirmasens, where 811 out of every 1,000 industrially active persons are employed in the shoe industry, one of the specialties of all Palatinate. Kaiserslautern, the capital, possesses a considerable number of smaller industries, among which the manufacture of sewing machines is probably the best known. Other cities of the populous Palatinate became fairly prosperous by making a close adjustment to their physical environments, such as Neustadt, Landau, and Speyer to wine, tobacco, and agriculture, in general.

CONCLUSION

Any economic analysis by locating factors is necessarily lacking the thoroughness which a more statistical survey would require. The analytical treatment of Bavaria's economic life, as has been attempted here, does, therefore, not claim completeness; it rather intended to bring out some of the typical and original adjustments which are underlying the present economic face of the country, and which since partly obliterated by modern development, do so easily escape the attention of an observer who is not familiar with the particular traits of Bavarian life.

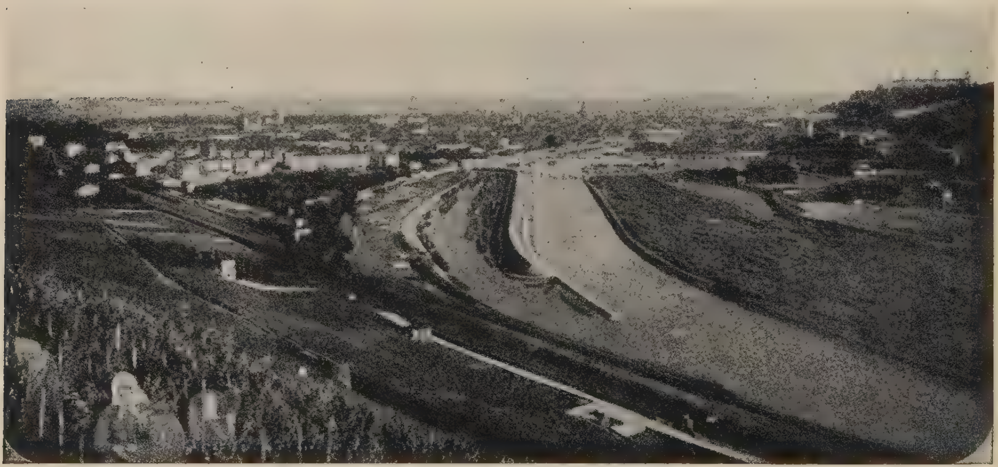

FIGURE 11.—Vineyards near Wuerzburg on the Main.

In summarizing it may be said, that Bavaria's economic adjustments to the large number of its environmental elements are as complex in nature as they are intensive in effect. That these adjustments have not succeeded and probably never will succeed in raising the economic standard of the country to the ideal of a harmonious economic unit is a fact which should not be forgotten over the estimable degree of economic balance already achieved. The country contributes a considerable share to Germany's economic needs from a few surplus products, and some of its specialties even reach into faraway markets; but in order to feed its 7 million people it is dependent upon import from various parts of Germany and from neighboring countries, and many a raw material from oversea is necessary to keep the wheels of its industries going.

If not all of its economic adjustments came up to the standard of modern efficiency, the reason may largely be found in the handicap of a slow historical evolution, as is the case with most old-world countries. But, it may in part also be attributed to the conservative character of its people. For, while the Bavarians are undoubtedly a progressive and temperamental people, there is among them a certain reluctance to adopt the hyper-modern ways of standardization, of condensing life into a single formula, a restraint almost second nature to a people, carrying on the struggle for existence in such manifold forms as the Bavarians do.

The keynote of Bavaria's economic life, which like other German regions suffers under the effects of the World War, is, therefore, and must continue to be, "quality rather than quantity," a keynote likely to strengthen the peculiar framework on which the economic welfare of the country is resting.

AGRICULTURAL REGIONS OF NORTH AMERICA

Part VIII—The Pacific Subtropical Crops Region (*Continued*)

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FRUITS AND NUTS

THE Pacific Subtropical Crops Region is unique in the production of fruit (Fig. 224). Although the acreage of all fruits in the region is only about one-fourth that of all crops, the value is fully half that of all crops. The great importance of fruit in the region is owing largely to the Mediterranean type of climate. Over 90 per cent of the dried fruit produced in the United States is produced in California. The principal fruits are grapes (about 650,000 acres in 1929), plums and prunes (230,000 acres), oranges (about 215,000 acres), peaches (155,000 acres), apricots (93,000 acres), pears (95,000 acres), apples (63,000 acres), figs (60,000 acres), lemons (46,000 acres), olives (32,000 acres), cherries (19,000 acres), grapefruit (7,000 acres), and avocados (5,000 acres). The following fruits are also grown commercially in the region: Japanese persimmons (3,000 acres), pomegranates (2,000 acres), loquats, guavas, tangerines, and citrons.[12]

Grapes are the principal fruit based on acreage, but citrus fruit has now a much greater value. The farm value of the grape crop in recent years has ranged from $50,000,000 to $55,000,000, except in 1928, when it fell to only $36,000,000. Three-fourths of all the grapevines in the United States are in California, and these produce nearly nine-tenths of the crop of the nation. The great center of production is the San Joaquin Valley, where there are nearly 500,000 acres of vines (Fig. 225). Some of these grapes are shipped to the East for table use, more are made into wine, and much more are dried into raisins, principally on the farm where grown. Most of the raisins of the United States, and over half of the raisins of the world, are produced in this valley (Figs. 226 and 227). The sunshine is almost continuous in the summer and early fall. Most of the grapevines are irrigated, but few are fertilized. Fresno is the center of this raisin area. About one-fourth of the raisins are exported, mostly to northwestern Europe and Canada.

In the Sacramento Valley there are about 45,000 acres of grapes, over one-third of which are in the Sacramento County. In this valley table and juice (wine) grapes mostly are grown. These grapes are largely grown without irrigation, but the use of water is increasing. In the valleys to the north and south of San Francisco Bay there are 55,000 acres in vines, mostly juice grapes. Only a small acreage is irrigated. The wines from these valleys formerly were famous, and some wine is still produced for medical and sacramental purposes. In the Valley of Southern California there are about 64,000 acres of grapes, mostly on the very

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[12] California Crop Report, 1928, by E. E. Kaufman and others, Calif. State Dept. of Agr. and U. S. Dept. of Agr. coöperating, Sacramento, 1929.

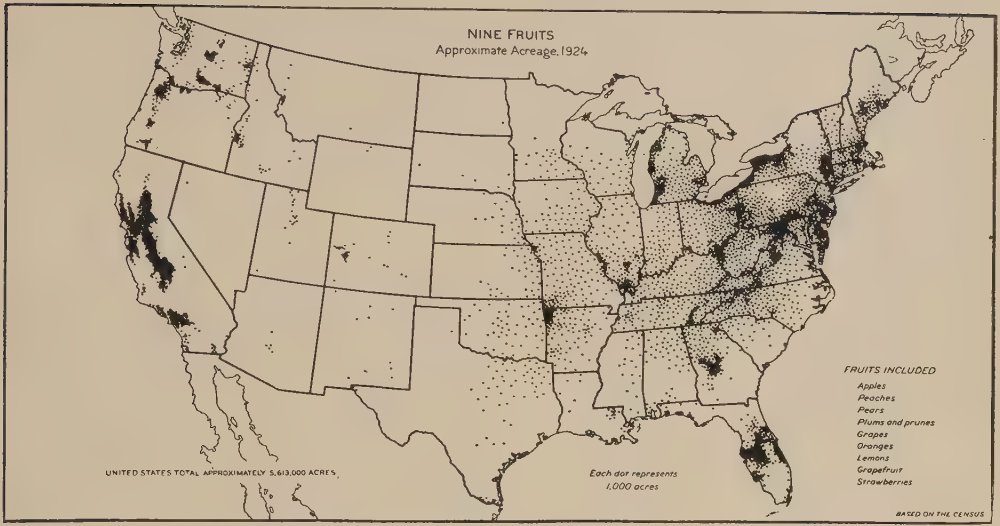


FIGURE 224.—California contributed over one-sixth of the nation's acreage of fruits and nuts in 1919 and over one-third of the value. The proportions are probably greater today. The district in Southern California consists mostly of citrus fruits, walnuts, and apricots, with some peaches and grapes; the San Joaquin Valley district is largely devoted to grapes, peaches, and apricots, with some citrus fruit and figs; the Sacramento Valley district is more mixed, including grapes, peaches, prunes and plums, apricots, pears, almonds, and some citrus and walnuts; while the valleys to the north and south of San Francisco Bay specialize in prunes, grapes, apricots, and pears, with some almonds and walnuts and with apples in the Sonoma and Pajaro valleys, where the air is cooled by breezes from the ocean. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

sandy soils between Rialto and Ontario. These are largely unirrigated. Many of the largest orchards in this valley and elsewhere are operated by natives of Italy or their descendants. Contrary to expectations, national prohibition of alcoholic beverages proved a great boon to the grape industry of California. The number of vines increased 60 per cent between 1919 and 1924, whereas between 1909 and 1919 the number had decreased. Between 1924 and 1928 the bearing acreage further increased 25 per cent, and there is serious overproduction.

Citrus fruits now greatly exceed grapes in value, owing partly to the low prices of grapes, but occupy less than half as large an acreage. Oranges constituted about 80 per cent of the total citrus acreage in 1924; lemons, 18 per cent; and grapefruit, 2 per cent. The citrus center is in Southern California, principally on the alluvial fans and piedmont slopes that partly surround the valley which extends from Los Angeles east to Redlands, and on the large alluvial fan in Orange County built up by the Santa Ana and Santiago rivers (Fig. 228). Water for irrigation is obtained from the streams higher up in the mountain canyons and from wells sunk in the alluvial fans or "washes." The elevation of these fans also provides excellent drainage, both of water and of air. Three-fourths of the bearing orange trees in the region (about 145,000 acres) and nearly all of the trees not of bearing age (23,000 acres) are in Southern California (Figs. 229–230). Most of the remainder are in the San Joaquin Valley, largely in the Porterville and Lindsay districts in Tulare County. There are also a number of orange orchards on the piedmont margins

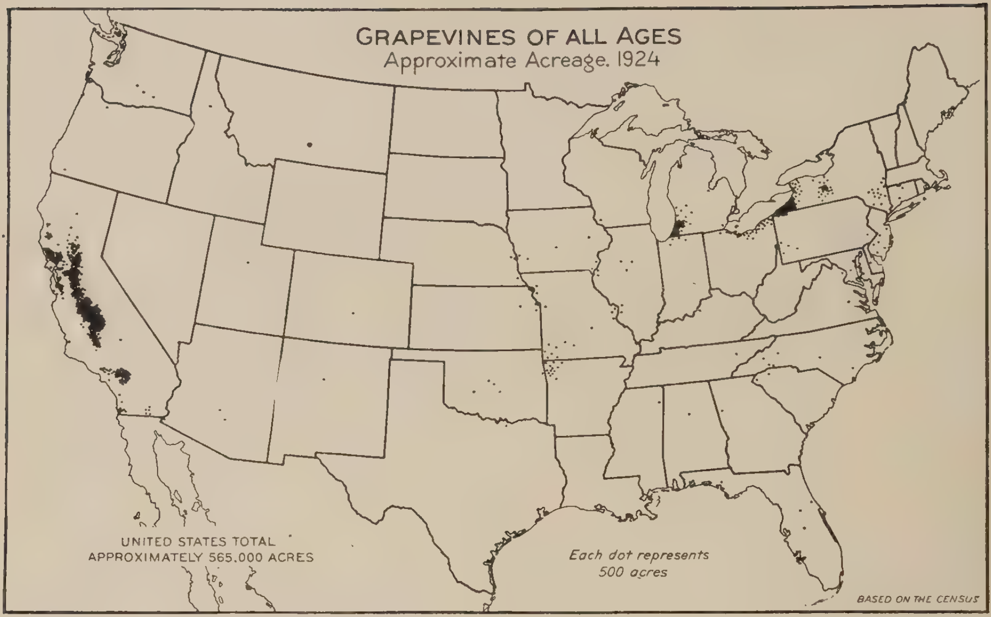


FIGURE 225.—Three-fourths of the nation's acreage of grapes is in California. The major district, devoted largely to raisins, centers around Fresno, in the San Joaquin Valley, where the land is nearly level and the sunshine almost continuous. The production of table grapes is also important in the San Joaquin Valley, but extends northward into the Sacramento Valley. Wine or juice grapes are grown in many parts of the state, but the bulk of production is in the Sacramento Valley and the valleys to the north and south of San Francisco Bay. A smaller center of grape production may be noted in Southern California, the largest vineyards lying a few miles west of San Bernardino. The area in grapes in California is now about 650,000 acres, and the average production about 2,300,000 tons (excluding 150,000 tons left unpicked). (Map from 1921 Yearbook, U. S. Dept. of Agr.)

of the Sacramento Valley in Sacramento, Butte, and Glenn Counties. The value of the orange crop of California in recent years has ranged from $60,000,000 to $90,000,000.

Lemons, likewise, are grown mostly in Southern California, and, unlike oranges, there is as large acreage outside the Los Angeles-Redlands Valley as in it. There are about 12,000 acres in Los Angeles County, 8,000 in northern Orange County and nearly as many in Ventura County, largely in the Santa Paula district, over 5,000 acres in San Bernardino County and nearly 5,000 in San Diego County, 4,000 acres in Riverside County and 2,000 acres in Santa Barbara County. There are also about 3,000 acres of trees in the San Joaquin Valley, and 850 acres in the Sacramento Valley. The value of the lemon crop of the State averages $20,000,000.

Grapefruit is grown in the Los Angeles-Redlands Valley, but the acreage in the Imperial Valley in the desert on the east side of the mountains, mostly young trees, is now slightly greater. Production of grapefruit is, as yet, not very important in the Pacific Subtropical Crops Region, amounting to nearly 1,000,000 boxes. There are about seven times as many lemon trees as grapefruit in the region, and nearly thirty times as many orange trees. Grapefruit, as well as oranges and lemons, are practically always irrigated and heavily fertilized. Cover crops are often grown in the winter and plowed under in the spring. The marketing

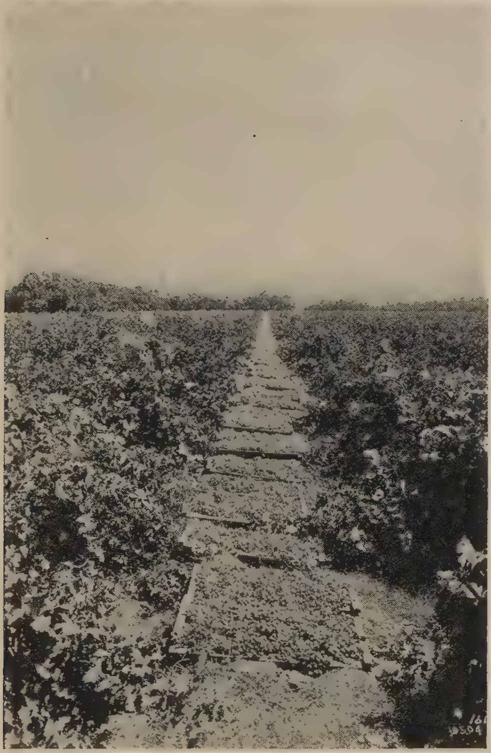


FIGURE 226.—This picture, taken in the San Joaquin Valley, shows the trays of grapes drying into raisins in the sun, and the vines from which the grapes were picked growing on either side. It will be noted that the vines are not supported by wires and grow only 3 to 5 feet high, the support being the trunk of the vine. The average yield per acre of grapes in this district is 4 tons, which dry into about one ton of raisins. (Photo from California Development Assn., San Francisco.)

of the citrus fruit of the region is doubtless the best organized of any agricultural commodity in the nation (Figs. 231, 232, and 233).

There is almost no citrus fruit grown commercially in the coastal valleys that drain into San Francisco Bay, nor in the Salinas Valley or along the coast north of Point Conception. The climate is a little too cool.

Prunes and plums, on the other hand, are produced principally in the San Francisco Bay valleys—nearly 80,000 acres in the Santa Clara Valley, nearly 30,000 acres in the Sonoma Valley, and 12,000 acres in the Napa Valley. These are mostly prunes. A large area, 60,000 acres, is also found in the Sacramento Valley, and nearly 30,000 acres in the San Joaquin Valley. The Pacific Subtropical Crops Region produces over half, in some years three-fourths, of the prunes of the world. Usually about half of the prunes are exported, mostly to northwestern Europe. The farm value of the crop ranges from $15,000,000 to $25,000,000 a year, to which should be added $2,000,000 for plums. A third of the fresh plum crop of the United States is produced in California.

Peaches are grown principally in the Great Valley (Figs. 234 and 235). There were, in 1924, about 60,000 acres of trees on the east side of the San Joaquin Valley, centering around Fresno and Merced, and nearly 50,000 acres in the Sacramento Valley centering in Sutter County. Nearly all the peaches are irrigated in the San Joaquin Valley, except where the water table is near the surface, but only a part of the orchards in the Sacramento Valley. Most of the peaches are canned or dried. In addition, Southern California had 23,000 acres of trees, mostly in the Ontario-Cucamonga section, and in the Hemet and San Fernando valleys. Table peaches are produced in the Beaumont-Yucaipa district. The value of the peach crop of California ranges from $10,000,000 to $20,000,000 annually. California produces about 98 per cent of the canned peach pack of the United States and practically all of the dried peaches. The dried peaches of California constitute over 90 per cent of the dried peach production of the world.

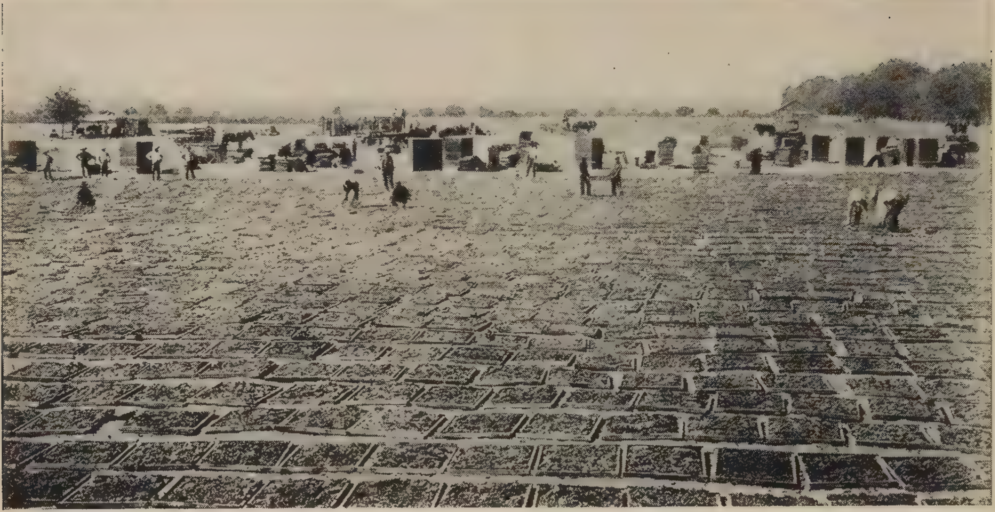
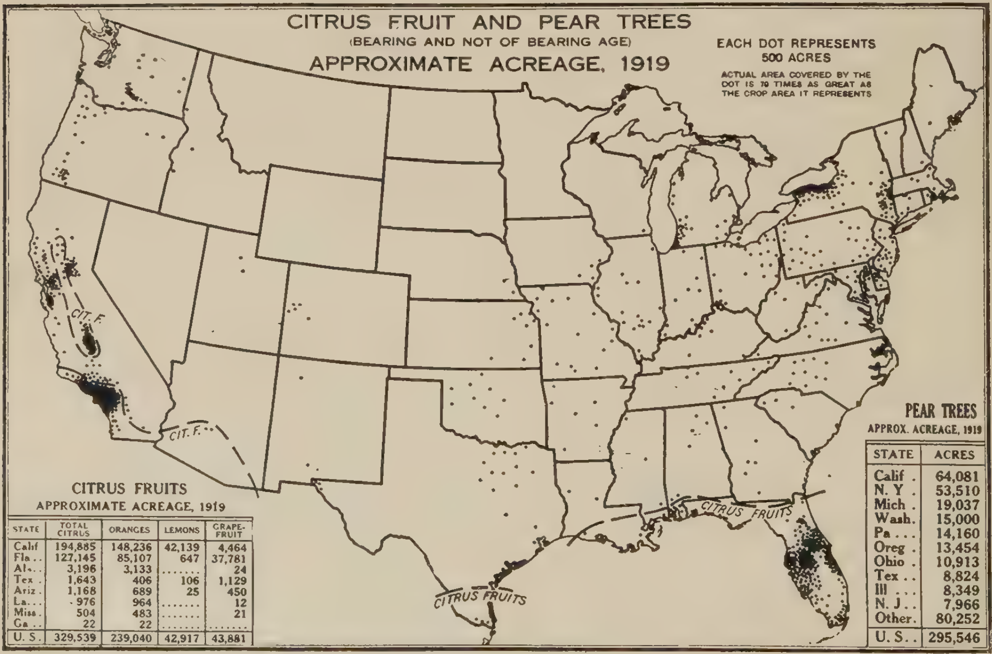


FIGURE 227.—Trays of raisin grapes drying in the sun. As the industry has grown, the assembling of the trays in one area has been found desirable. The sheds in the background are used for bleaching the raisins by means of sulphur dioxide fumes. However, only a small proportion of the raisin crop is bleached. (Photo from U. S. Bur. of Agr. Economics.)

Apricots are also an important crop in the region. The three principal centers of production are the Santa Clara Valley at the south end of San Francisco Bay, the San Joaquin Valley, and the valleys of



CITRUS FRUIT AND PEAR TREES
(BEARING AND NOT OF BEARING AGE)
APPROXIMATE ACREAGE, 1919
EACH DOT REPRESENTS 500 ACRES
ACTUAL AREA COVERED BY THE DOT IS 70 TIMES AS GREAT AS THE CROP AREA IT REPRESENTS
CIT. F.
CIT. F.
CITRUS FRUITS
CITRUS FRUITS

CITRUS FRUITS
APPROXIMATE ACREAGE, 1919

STATE	TOTAL CITRUS	ORANGES	LEMONS	GRAPE-FRUIT
Calif	194,885	148,236	42,139	4,464
Fla . .	127,145	85,107	647	37,781
Ala . .	3,196	3,133	....	24
Tex .	1,643	406	106	1,129
Ariz .	1,168	689	25	450
La . . .	976	964	....	12
Miss .	504	483	....	21
Ga . .	22	22	....	....
U. S.	329,539	239,040	42,917	43,881

PEAR TREES
APPROX. ACREAGE, 1919

STATE	ACRES
Calif .	64,081
N. Y .	53,510
Mich .	19,037
Wash.	15,000
Pa . . .	14,160
Oreg .	13,454
Ohio .	10,913
Tex . .	8,824
Ill . . .	8,349
N. J . .	7,966
Other.	80,252
U. S. .	295,546

FIGURE 228.—Over half of the nation's acreage of citrus fruit is in California, nearly 45 per cent in Florida, and 5 per cent in Texas and the Gulf States and in Arizona. In California about 80 per cent of the acreage is in Southern California and nearly 20 per cent in the Great Valley. The citrus fruit is grown mostly on the alluvial fans and piedmont slopes, where there is less danger from frost. Practically all the acreage is irrigated. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

Southern California. Unlike prunes and peaches, a considerable proportion of the crop is sold fresh for consumption in the state. However, over two-thirds of the apricots are dried and one-fourth are canned. The crop averages about $10,000,000 in value. California produces over 99 per cent of the apricot crop of the nation.

Pears, apparently, prefer a little cooler climate than peaches and apricots, especially in winter. The acreage in the valleys to the north of San Francisco is larger than in the Santa Clara Valley to the south, and a large acreage is also found on the foothills and valley slopes of the Sacramento Valley, notably in Sacramento, Solano, and Placer Counties. There are over 5,000 acres in Los Angeles County, principally in the Antelope and San Fernando valleys. The total area in the region is 95,000 acres. More than half the pears (about 57 per cent) are shipped fresh to Eastern markets, about 30 per cent are canned, and about 12 per cent are dried. The farm value of the crop varies from $7,000,000 to $10,000,000.

Apples are grown in the cooler parts of the region, principally in the Watsonville district on the eastern shore of Monterey Bay and adjoining Pajaro Valley, and in the Sebastopol district on the west side of the Sonoma Valley, which is one of the leading early apple districts in the United States. Both these districts are exposed to the fogs and cool winds from the ocean. Apples are also grown in the Yucaipa Basin in the San Bernardino Mountains and around Beaumont and Banning, at an elevation of 2,200 to 2,600 feet. Here the temperatures are lower than

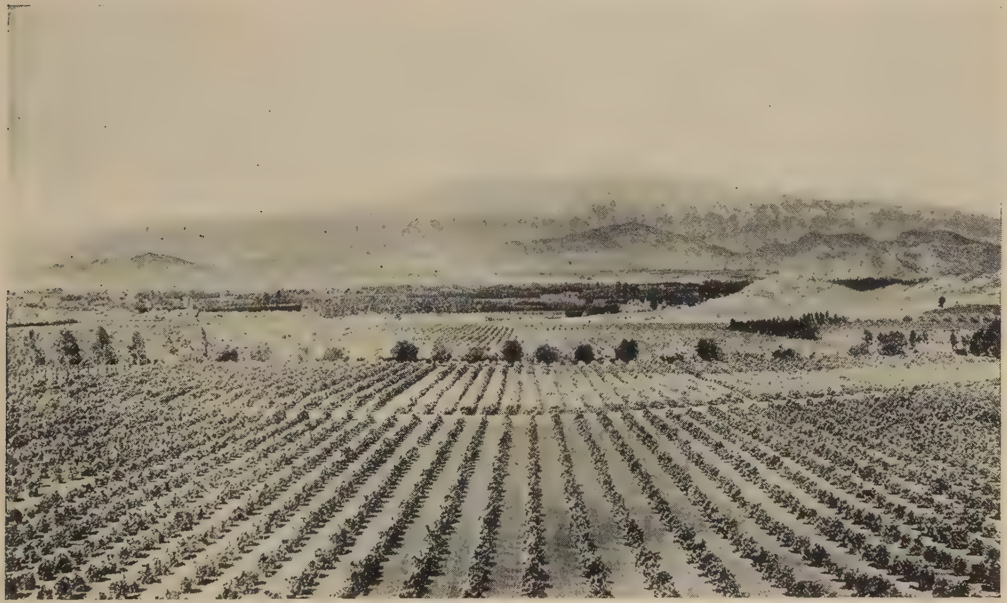


FIGURE 229.—This picture, taken in Southern California, shows young orange trees in the foreground, apricot trees in bloom beyond on the slightly lower land, eucalyptus trees in the valley bottom in the middle distance, doubtless with grain crops and pasture in the fields between the tree rows, while on the opposite slopes of the valley fruit orchards may be seen indistinctly. Rising behind are the San Bernardino Mountains, partly snow-covered, from which comes most of the water for the orchards in the valley. (Photo by G. Harold Powell, formerly of Bur. of Plant Industry.)

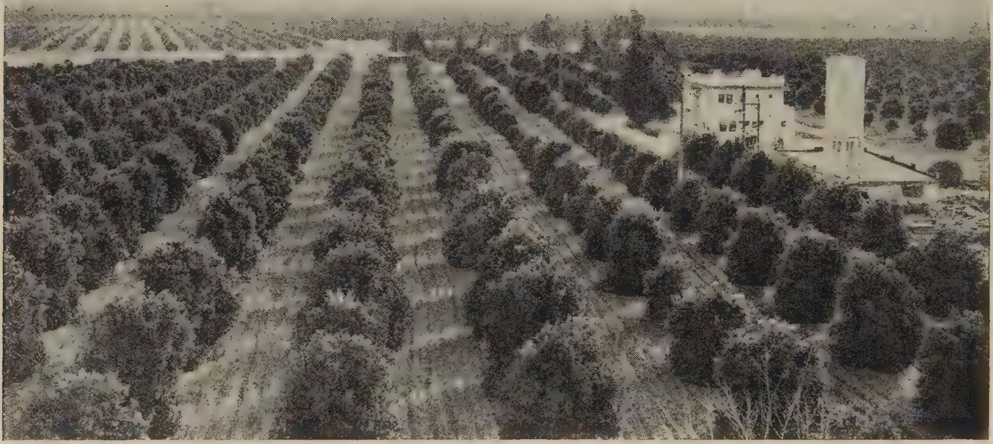


FIGURE 230.—A nearer view of an orange grove, with a fairly characteristic house, garage, and water tank. Notice the tillage between the trees and the furrows evidently prepared for irrigation, also the wide spacing between the trees to allow ample room for the roots and for the sun to color the fruit. Such wide spacing is convenient, moreover, when driving a team of horses between the rows in cultivating and harvesting. (Photo from Los Angeles Chamber of Commerce.)

in the nearby valleys, but much higher than in the coastal districts. The apples in the coastal districts are mostly unirrigated, but those in the Southern California mountains are irrigated. The value of the apple crop of California ranges from $5,000-000 to $10,000,000.

Cherries (nearly all sweet) are much less important, only about 1,500,000 trees in the region. The crop, which is mostly canned, has brought in recent years from $2,000,-000 to $4,000,000. Cherries are grown principally in the San Francisco Bay valleys, and in the cooler, central portion of the Great Valley, near its opening into San Francisco Bay. There are also a number of orchards in the Southern California valleys. Olives are an important fruit in certain sections of Southern California, notably in Los Angeles, Riverside, and San Diego Counties, in the central San Joaquin Valley, and in Butte, Sacramento, and Placer Counties, in the Sacramento Valley. There are about 1,500,000 trees in the region and the average crop is worth $1,000,000. Olives are very resistant

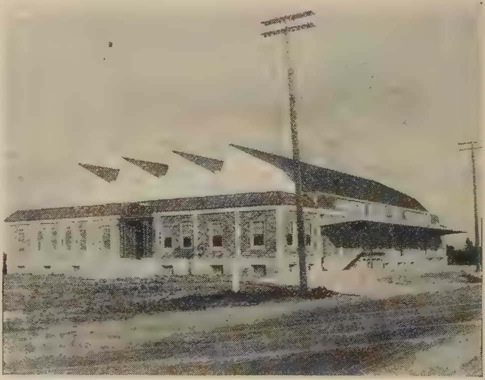


FIGURE 231.—Typical citrus packing house in Southern California. Notice the roof arrangement to admit abundant light and the artistic office entrance. (Photo from U. S. Bur. of Agr. Economics.)

to drought and most of the orchards are unirrigated. Unlike Mediterranean olives the California crop is mostly picked ripe, as there is no fly to make wormy fruit.

Figs likewise are an important fruit locally in the central San Joaquin Valley, with a few trees in the Sacramento Valley, and in Los Angeles and San Diego Counties in Southern California. There were in all about 1,000,000 trees in the region in 1920, and the crop in recent years has sold for from $500,000 to $1,500,000. California produces about one-third of the dried figs consumed in the United States, two-thirds being imported. Recently about 10 per cent of the crop has been canned fresh and 6 per cent eaten in the fresh state.

The only other fruits of much commercial importance are avocados, whose production is almost confined to Southern California; Japanese persimmons, which are also grown mostly in Southern California and in Tulare and Placer Counties in the Great Valley; and pomegranates, grown mostly in Tulare County. Guavas, loquots, and tangerines are grown commercially by a few farmers, and it is quite common for city dwellers, as well as farmers, to have a tree or two of each growing in the yard to produce fruit for home use.[13]

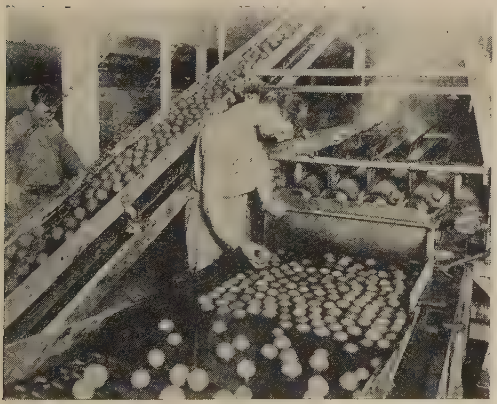


FIGURE 232.—Washing oranges in a packing house. Notice the revolving rollers to rub off all dirt or adhering spray, and the endless belt conveyors. (Photo from U. S. Bur. of Agr. Economics.)

The list of California products would not be complete without mentioning nuts. Walnuts ("English" or "Persian") are a very important crop in Southern California, particularly in Los Angeles, Orange, and Ventura Counties (Fig. 236). However, a few orchards produce fruit for sale in nearly every county in the region. There were about two million trees in the state in 1920 (Fig. 237), and the area of bearing trees is estimated in 1929 as 87,000 acres, with 40,000 acres more not of bearing age. The value of the crop in recent years has ranged from $7,000,000 to $17,000,000. Almonds are the other important nut. These are grown mostly in San Luis Obispo County in the Central Coast sub-region, in the Sacramento Valley, and in the northern, cooler portion of the San Joaquin Valley. There are, however, a number of orchards in Southern California and in the "Bay Counties." The number of trees in the region totaled nearly four millions in 1920, and the present value of the crop is about $10,000,000. The estimated area in 1929 was 92,000 acres of bearing trees and 6,000 acres of non-bearing trees.

VEGETABLES

California is also the greatest vegetable-producing state in the nation, and, except for the Imperial Valley, nearly all the commercial crop is produced in the Subtropical Crops

[13] Dates are a crop of rapidly increasing importance in the Coachilla Valley of Southeastern California, but no dates are produced commercially in the Subtropical Crops Region.

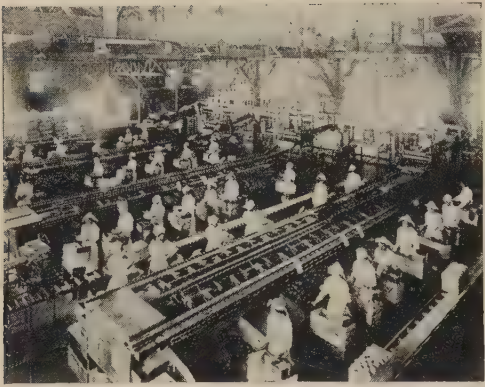
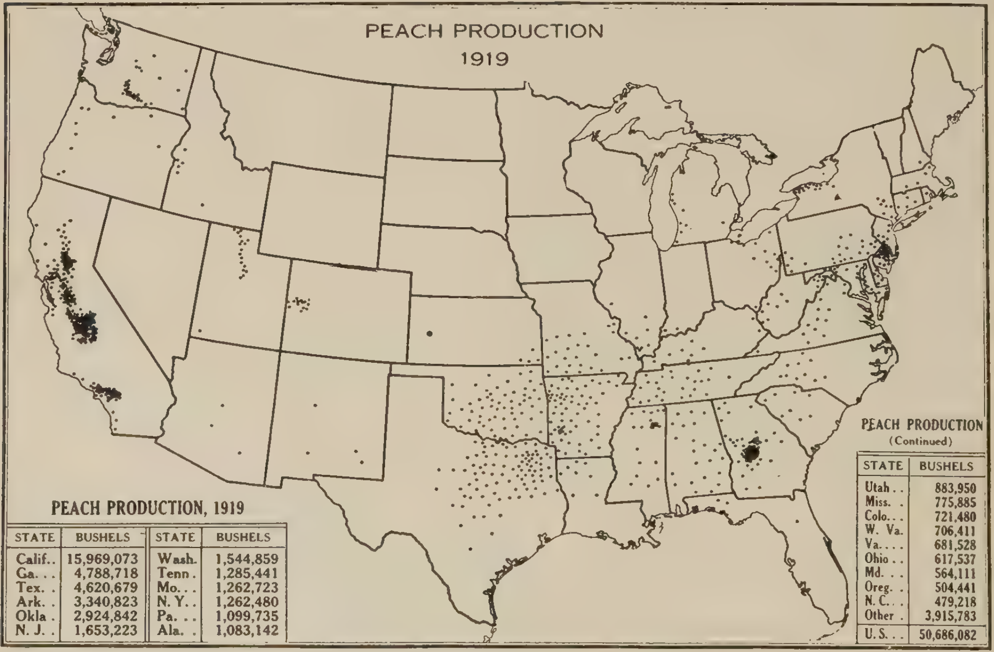


FIGURE 233.—Inside the packing house. Notice the machines which sort the oranges in standard sizes, and the wrapping in tissue paper and packing, which is done by hand; note also the belt conveyors carrying the packed boxes away. Box material can be seen on the left, and a machine for assembling and nailing boxes on the right beyond the sorting machines. (Photo from U. S. Bur. of Agr. Economics.)

Region (Fig. 238). Potatoes have been the leading vegetable in area until recently, occupying about 50,000 acres. The cool "Delta" district, where the Sacramento and San Joaquin Rivers have built up a marshy area with muck soils, is one of the important potato-producing districts of North America. There are also several thousand acres in Southern California, mostly near Los Angeles. These are principally early potatoes. The average value of the crop in the state is about $10,000,000. Tomatoes rank second in acreage, occupying usually from 40,000 to 50,000 acres. The centers of production are in Southern California, especially around Los Angeles, in the cooler central section of the Great Valley, in the Santa Clara Valley, and in Alameda County. The tomatoes are both canned and shipped fresh, especially in the late fall. The crop normally is worth about $5,000,000.

Lettuce recently has become a very



PEACH PRODUCTION, 1919

STATE	BUSHELS	STATE	BUSHELS
Calif..	15,969,073	Wash.	1,544,859
Ga. . .	4,788,718	Tenn.	1,285,441
Tex. .	4,620,679	Mo. . .	1,262,723
Ark. .	3,340,823	N. Y. .	1,262,480
Okla .	2,924,842	Pa. . .	1,099,735
N. J. .	1,653,223	Ala. .	1,083,142

PEACH PRODUCTION
(Continued)

STATE	BUSHELS
Utah . .	883,950
Miss. .	775,885
Colo. . .	721,480
W. Va.	706,411
Va. . . .	681,528
Ohio . .	617,537
Md. . .	564,111
Oreg. .	504,441
N. C. . .	479,218
Other .	3,915,783
U. S. . .	50,686,082

FIGURE 234.—California produces from one-fourth to one-half of the nation's peach crop, varying with the season, Fresno County alone producing normally one-tenth. About half of the peaches of California are grown in the San Joaquin Valley. Other important districts are located in the Sacramento Valley and in Southern California, but it will be noted that there are relatively few peaches in the valleys north and south of San Francisco Bay. Most of the peaches of California are canned, but a few are shipped fresh to the Eastern States. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

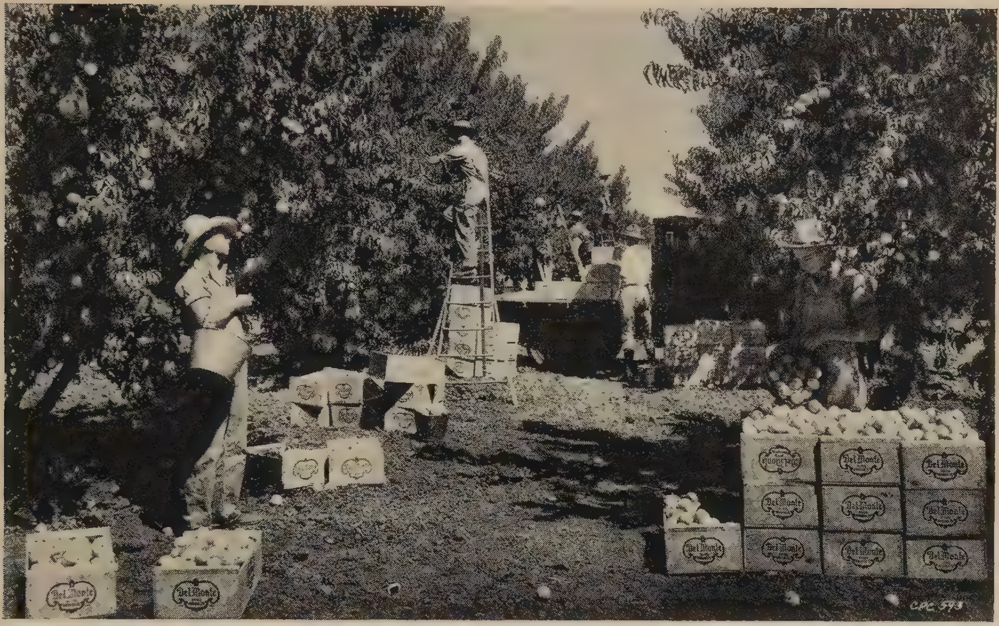


FIGURE 235.—Picking peaches in the San Joaquin Valley. Note that the peaches are picked into pails, then dumped into boxes, which are loaded on trucks and hauled to the canning factory. Also notice the bright sunshine and the sharp shadows characteristic of a dry climate. (Photo supplied by California Packing Corporation, through the California Development Assn.)

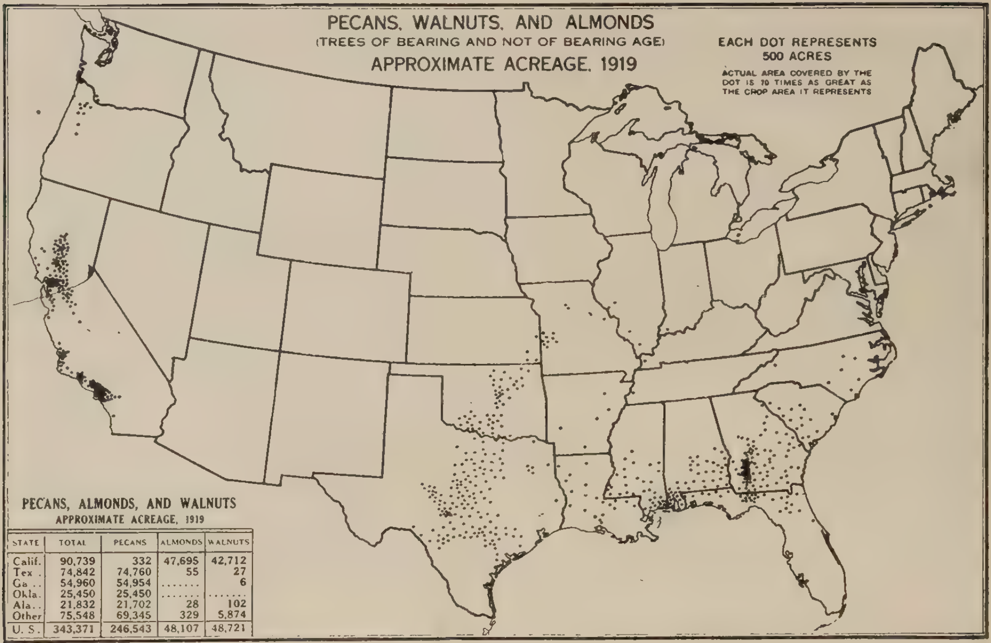
important crop. The area in lettuce, excluding the Imperial Valley, ranges now from 40,000 to 60,000 acres, and the value of the crop in the region in 1928 and 1929 exceeded that of potatoes, being about $14,000,000. Nearly two-thirds of the nation's commercial crop is now grown in California, and lettuce even in the Eastern States has become almost as common and as cheap in winter as in the summer. Car-lot shipments both from California and from other states have increased four-fold during the past decade. This is owing largely to the development of a superior variety, the Iceberg. California also produces over two-thirds of the nation's asparagus, grown mostly in the Delta district. The acreage of asparagus in California now exceeds that of potatoes. This is true also of

TABLE I

CALIFORNIA COMMERCIAL VEGETABLE CROPS

TREND OF CAR-LOT SHIPMENTS IN RECENT YEARS AND FARM VALUE OF CROP IN 1928

Crop	*Car-Lot Shipments—Number of Cars*					*Estimated Value of Crop*
	1920	1922	1924	1926	1928	1928
Asparagus	502	304	718	1,503	1,876	$8,800,000
Cabbage	913	647	376	412	702	1,100,000
Cantaloupes	13,251	15,304	19,932	18,320	25,271	12,300,000
Carrots	111	21	157	557	2,929	1,900,000
Cauliflower	2,957	3,604	3,404	4,730	7,525	3,000,000
Celery	3,472	4,334	4,240	7,565	9,560	2,700,000
Lettuce	7,358	9,744	18,480	27,341	33,446	20,100,000
Onions	4,802	4,349	2,671	3,013	4,489	2,200,000
Peas (green)	.....	.....	.....	803	1,636	5,000,000
Potatoes	10,953	7,766	9,714	8,614	7,562	5,100,000
Spinach	326	302	70	305	334	1,400,000
Sweet Potatoes	856	982	466	1,186	767	1,300,000
Tomatoes	2,004	2,349	2,789	4,443	4,423	5,400,000
Watermelons	3,390	4,302	4,305	6,278	5,593	1,100,000


PECANS. WALNUTS. AND ALMONDS
(TREES OF BEARING AND NOT OF BEARING AGE)
APPROXIMATE ACREAGE. 1919
EACH DOT REPRESENTS 500 ACRES
ACTUAL AREA COVERED BY THE DOT IS 70 TIMES AS GREAT AS THE CROP AREA IT REPRESENTS

PECANS, ALMONDS, AND WALNUTS
APPROXIMATE ACREAGE, 1919

STATE	TOTAL	PECANS	ALMONDS	WALNUTS
Calif.	90,739	332	47,695	42,712
Tex .	74,842	74,760	55	27
Ga . .	54,960	54,954	....	6
Okla.	25,450	25,450	....	....
Ala. .	21,832	21,702	28	102
Other	75,548	69,345	329	5,874
U. S.	343,371	246,543	48,107	48,721

FIGURE 236.—Only three kinds of nuts are produced in the United States on a commercial scale—pecans, walnuts, and almonds. The pecans are practically confined to the Southern States, the walnuts and almonds to California, except for a small acreage of walnuts in western Oregon and Washington. The area shown in Southern California is mostly walnuts, while in the Great Valley both nuts are grown, and in the Santa Clara Valley mostly almonds. Only about half the walnut acreage and a quarter of the almond acreage in California is irrigated, according to the Census. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

cantaloupes in 1929. Two-thirds of the nation's car-lot shipments of cantaloupes originate in California, but three-fourths of the 40,000 to 50,000 acres in California are in the Imperial Valley, which lies outside the Pacific Subtropical Crops Region (Figs. 239 and 240). Green peas have recently become an important crop, occupying 19,000 acres in 1929, with 13,000 acres more in the Imperial Valley. Nearly all kinds of vegetables grown anywhere in the United States are grown extensively in California. Table I shows the trend of car-lot shipments of vegetables in alternate years since 1920 and also the value in 1928.

GARDEN SEEDS AND FLOWERS

In addition to providing the markets of the nation with a large proportion of the winter vegetable supply, California provides most of the vegetable and flower seeds for the nation. In the Santa Clara Valley there are hundreds of acres devoted to this industry and the business has now spread to other parts of the state. Many carloads of flowering plants and flowers are also shipped east during the winter season. Fields of these seed and flower crops in bloom are a pretty sight—one of the most beautiful in a beautiful state.

PASTURES

Although there are probably over 30,000,000 acres of pasture land in the Pacific Subtropical Crops Region, only 12,000,000 acres were reported in farms by the census in 1924. Of this acreage about 2,500,000 was pasture land that "could be plowed and used for crops without clearing,

FIGURE 237.—The Persian or French walnut is a beautiful tree, with a smooth light-colored bark and far-spread branches, well covered with leaves. This picture, taken in Southern California, shows a road through a walnut orchard. The walnuts on the trees are too small to be seen. The average production is from one-third to one-half ton per acre, and there are about 90,000 acres of bearing trees and 40,000 acres of non-bearing trees in California. (Photo from Los Angeles Chamber of Commerce.)

draining, or irrigating," another 2,500,000 acres were woodland pasture, and 7,000,000 acres were reported as "other" pasture, which means natural grassland not suitable for crop production.

Two-thirds of the plowable pasture is located in the Great Valley and consists almost wholly of valley lands capable of growing grain; in fact, most of it doubtless has grown grain in years past. A little of it (perhaps 200,000 acres) is alfalfa pasture. About one-fifth of the plowable pasture is in the hills and valleys west of the Great Valley and north of Point Conception, and still less is in Southern California. Over half of the woodland pasture is also found in the Great Valley, and consists of both the open live-oak groves and the "chaparral" belt that fringes the valley on both sides.[14] In addition to the 2,500,000 acres in farms, there are about 3,000,000 acres not in farms in the Region.

The native grassland pasture too dry or too rough for crops is much more extensive. Half of the area reported in farms was in the Great Valley; a third in the Coast ranges and valleys; and less than a sixth in Southern California. This natural grassland is of diverse character. Apparently before the coming of the stockmen, the principal species were California Poa (blue grass) and a stepa (needle grass), with scattered lupines and clovers. These early gave way, owing to overgrazing, to wild oats and bur clover, and these in turn to filaree, then fox-tail grass, and, finally, to red brome grass. At present this grassland is characterized by weedy annual plants, which "following the winter rains produce a luxuriant carpet, dotted by many showy flowering plants, such as California poppy. The vegetation matures early and remains during a long summer rest period in a dried condition."[15] Most of this natural grassland is used as yearlong range, and the carrying capacity ranges from 25 to 75 acres per cow or mature steer. Along the eastern side of the Great Valley some of this grazing land will carry a cow on as few as fifteen acres.

LIVESTOCK

Prior to American annexation at the close of the Mexican War, much of the land in the Pacific Subtropical Crops Region was owned by Mexi-

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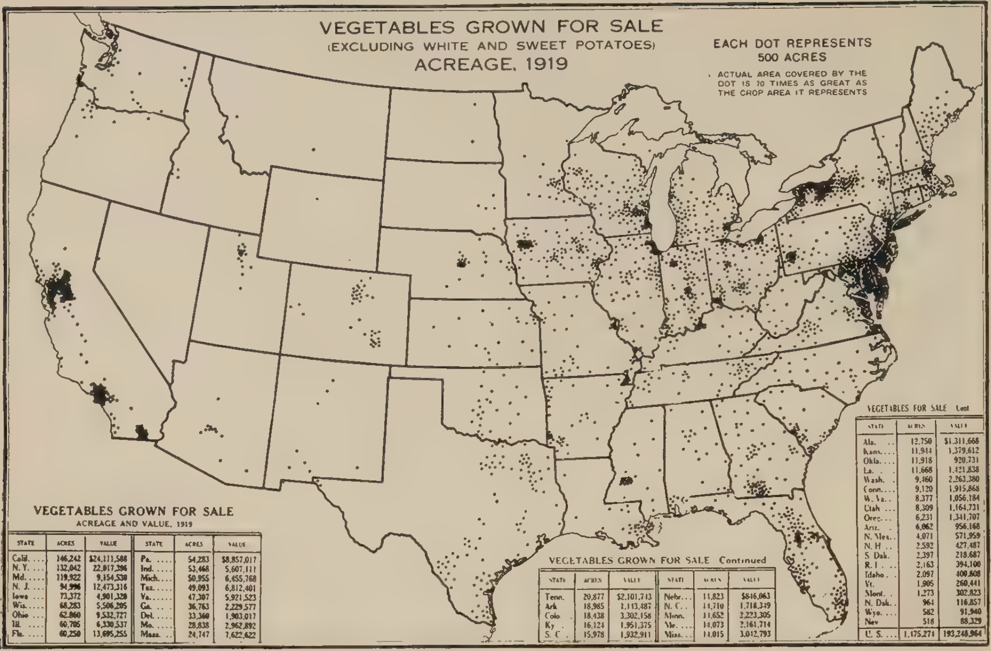
[14] Chaparral is a growth of shrubs and small trees and consists largely of Highland live-oak (*Quercus wislizeni*), scrub-oak (*Quercus Jumosa*), hollyleaf cherry (*Prunus ilicifolia*), sumac (*Rhus laurina*), wild lilac (*Ceanothus hirsutus*), and manzanita (*Arctostaphylos glauca*). Growing between the shrubs are several grasses and numerous flowering plants.

[15] Shantz and Zon: "Atlas of American Agriculture," Section Natural Vegetation, U. S. Dept. of Agr., 1924. Sequence of vegetation resulting from overgrazing, worked out by E. O. Wooten, Bureau of Agricultural Economics.


VEGETABLES GROWN FOR SALE
(EXCLUDING WHITE AND SWEET POTATOES)
ACREAGE, 1919
EACH DOT REPRESENTS 500 ACRES
ACTUAL AREA COVERED BY THE DOT IS 10 TIMES AS GREAT AS THE CROP AREA IT REPRESENTS

VEGETABLES GROWN FOR SALE
ACREAGE AND VALUE, 1919

STATE	ACRES	VALUE	STATE	ACRES	VALUE
Calif.	146,242	$24,111,588	Pa.	54,283	$8,857,017
N. Y.	132,042	22,017,396	Ind.	53,468	5,607,111
Md.	119,922	9,154,530	Mich. ...	50,955	6,455,768
N. J.	94,996	12,473,316	Tex.	49,093	6,812,401
Iowa	73,372	4,901,320	Va.	47,307	5,921,523
Wis.	68,283	5,506,205	Ga.	36,763	2,229,577
Ohio	62,860	9,532,727	Del.	33,360	1,903,017
Ill.	60,705	6,330,537	Mo.	28,838	2,962,892
Fla.	60,250	13,695,255	Mass. ..	24,747	7,622,622

VEGETABLES GROWN FOR SALE Continued

STATE	ACRES	VALUE	STATE	ACRES	VALUE
Tenn.	20,877	$2,101,743	Nebr. ..	14,823	$846,063
Ark.	18,985	2,113,487	N. C. ..	14,710	1,718,349
Colo. .	18,438	3,302,158	Minn.	14,652	2,223,305
Ky. .	16,124	1,951,375	Me. ...	14,073	2,161,714
S. C. .	15,978	1,932,911	Miss. ..	14,015	3,042,793

VEGETABLES FOR SALE Cont.

STATE	ACRES	VALUE
Ala. ..	12,750	$1,311,668
Kans. ...	11,944	1,379,612
Okla. ...	11,918	920,731
La. . .	11,668	1,421,838
Wash. .	9,460	2,263,380
Conn. ...	9,120	1,915,868
W. Va. ..	8,377	1,056,184
Utah ...	8,309	1,164,731
Oreg. ..	6,231	1,341,707
Ariz. .	6,062	956,168
N. Mex. .	4,071	571,959
N. H. ..	2,592	427,487
S. Dak.	2,397	218,687
R. I. ..	2,163	394,100
Idaho . .	2,097	400,808
Vt.	1,905	260,441
Mont. .	1,273	302,823
N. Dak. .	964	116,857
Wyo. ...	582	91,940
Nev	518	88,329
U. S. ...	1,175,274	193,248,964

FIGURE 238.—California grows more vegetables than any other state. It possesses four major areas of production, three of which are in the Pacific Subtropical Crops Region. The largest district is in the central portion of the Great Valley, and includes the potato, celery, cabbage, and asparagus district of the marshy Sacramento-San Joaquin Delta, and the cantaloupe and watermelon district around Turlock. Tomatoes are an important crop in many places in the Great Valley. The vegetables grown in this valley are largely shipped East. Next in importance is the Los Angeles district where nearly all kinds of vegetables are grown, including sweet corn, principally for the Los Angeles market. Less important is the San Francisco Bay district which is mostly devoted to green peas, sweet corn, tomatoes, and other vegetables for the adjacent cities. There is also a considerable acreage of lettuce in the Salinas Valley. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

cans in large units, granted originally by the Spanish Crown, and used almost wholly for the production of beef cattle. Even now most of the land in the Coast ranges and valleys south of the Santa Clara Valley as far as the valleys of Southern California, also in the western portion of the San Joaquin Valley, is used for grazing cattle. But, with the intensive utilization of the best land for fruit, vegetables, and alfalfa, and with the development of an urban civilization, the dairy cow has been gradually replacing the beef animal, until now the farm value of milk and dairy products in the region amounts to fully $80,000,000 annually.[16] This is probably as much as in Ohio, Illinois, or Iowa, and is as great as the combined value of the grape and the prune crops. The value of the beef and veal produced, on the other hand, including that from dairy herds, probably does not exceed $40,000,000.

Over half the dairy cows in the Region are in the Great Valley (242,000 in 1924), principally in the San Joaquin section; one-fourth are in the San Francisco Bay district and valleys to the south as far as Point

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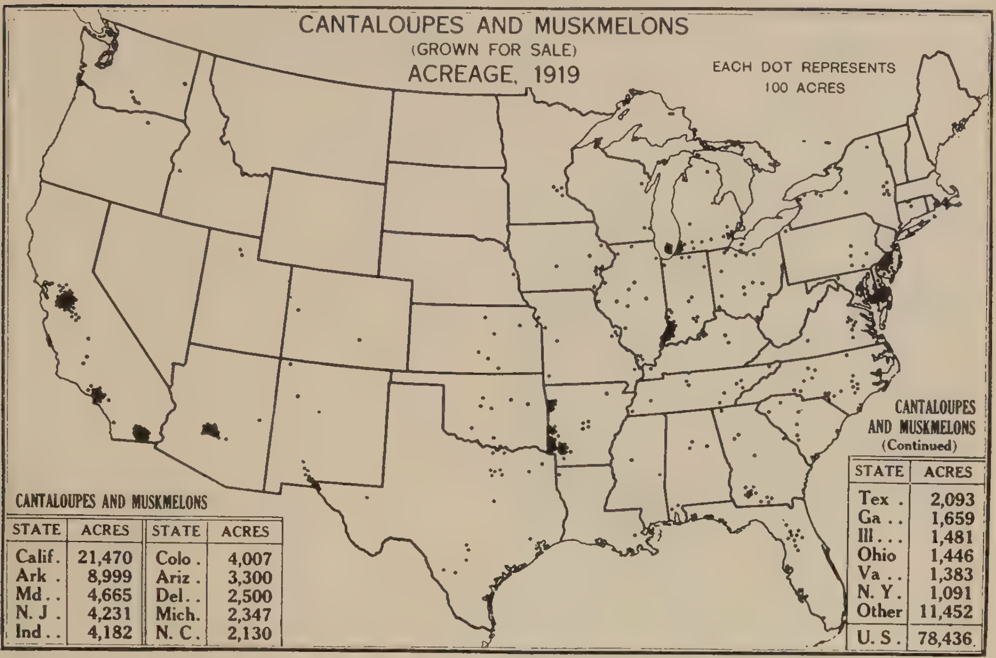
[16] The census for 1924 gives $50,000,000, but this was a very dry year. The "Statistical Report of California Dairy Products," issued by the State Department of Agriculture, gives the value of dairy products of California in 1927 and also in 1928 at over $150,000,000; but as this includes market milk at close to retail price, it appears better to use the estimates of value of milk fat sold by farmers. This was $89,000,000 in 1928. It is possible that the farm value of the milk produced may now (1929) be close to $100,000,000.



CANTALOUPES AND MUSKMELONS

STATE	ACRES	STATE	ACRES
Calif.	21,470	Colo.	4,007
Ark.	8,999	Ariz.	3,300
Md.	4,665	Del.	2,500
N. J.	4,231	Mich.	2,347
Ind.	4,182	N. C.	2,130

CANTALOUPES AND MUSKMELONS (Continued)

STATE	ACRES
Tex.	2,093
Ga.	1,659
Ill.	1,481
Ohio	1,446
Va.	1,383
N. Y.	1,091
Other	11,452
U. S.	78,436

FIGURE 239.—In California about 40 per cent of the nation's commercial cantaloupe and muskmelon acreage is found, and nearly a half of the production. There are three great centers of cantaloupe production in the state: the lower San Joaquin Valley, the Los Angeles district, and the Imperial Valley. Only the first two districts are in the Pacific Subtropical Crops Region. The Imperial Valley melons are mostly shipped East in the late spring and early summer, while the San Joaquin Valley and Los Angeles district melons are shipped chiefly in July and August, long before the Eastern melons are ripe. The car-lot shipments in 1928 totaled over 25,000 cars. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

Conception (117,000); and less than one-fourth in Southern California (84,000) (Fig. 241). Production of milk per cow, however, was slightly greater in Southern California in 1924, according to the census—700 gallons as compared with 650 gallons in the Great Valley and 630 gallons in the Central Coast and Valleys. The value of dairy products per cow was still greater in the southern sub-region—$155 per cow, as compared with $104 per cow in the Great Valley and $110 in the Central Coast sub-region. This is owing to the large city population in the Los Angeles district requiring a large proportion of the milk for table use. Market milk commands a higher price than milk to be made into butter or cheese.

There are few butter factories left in Southern California, except in the city of Los Angeles and in San Diego County, whereas there is a large production of butter in the San Joaquin Valley, also in the Sonoma Valley, especially in the hills along the western edge, and in San Francisco City. Cheese also is made in the Great Valley, in the Santa Clara Valley, and along the coast as far south as Monterey County. Nevertheless, the Subtropical Crops Region produces only about three-fourths as much butter and one-third as much cheese as it consumes, receiving large shipments from the North Pacific Coast and from the Eastern States.

Beef cattle are as numerous as dairy cattle in the San Joaquin Valley

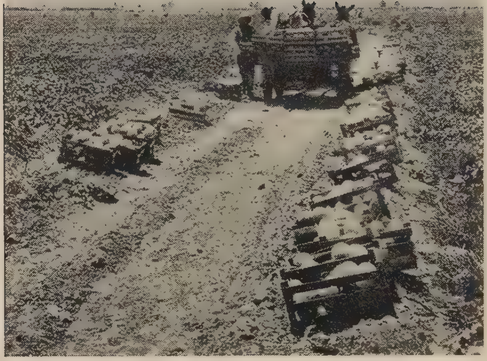


FIGURE 240.—Picking melons in Southern California. The melons are picked when still somewhat green, placed loosely in boxes and carried to the packing house. Here they are carefully sorted by condition and size and packed tightly for shipment across the continent in refrigerator cars. It may be ten days before they reach the consumer. (Photo from Los Angeles Chamber of Commerce.)

and more numerous in the Sacramento Valley, but the industry is really dominant only in the counties south from Monterey Bay to Point Conception. In this hilly and semiarid region the beef cattle industry has made its last stand, and seems likely to persist for many years. There were about 120,000 beef cows in the Great Valley in 1924; 75,000 in the Central Coast Ranges and Valleys; and 40,000 in Southern California. The total number of cattle in the region in 1924 was 1,350,000, about 60 per cent of which were in the Great Valley.

The sheep industry was formerly important throughout the Subtropical Crops Region. In 1880 California had more sheep than any other state, but by 1900 there were only a third as many, and in 1910 there were still fewer. The census of 1920, however, showed an increase of 50 per cent over 1910, and the 1924 Census showed an increase over 1920 of 25 per cent. There were over 2,400,000 sheep in the Subtropical Crops Region in 1924 and the estimate for 1928 is 2,600,000. The higher prices for lamb and wool in recent years have encouraged the sheep industry nearly everywhere in the United States. However, the sheep are now concentrated largely in the Great Valley (Fig. 242). These valley counties reported 90 per cent of the sheep in the region in 1924, but doubtless many of these sheep graze in the mountains on both sides of the valley. The Sacramento Valley in particular has developed into one of the major lamb producing districts in the United States, and is the leading winter lamb district. About $5,000,000 worth of wool was also produced in the region in 1924.

The swine industry is only slightly developed in California, as compared with the East, partly because there is little corn grown. But it would appear that the barley crop might be used more extensively to feed hogs, as it is in northern Europe. However, the farm value of the pork and lard produced in 1927, about $15,000,000, was about as great as the value of the lamb and mutton produced. Sixty per cent of the hogs are in the Great Valley, and, unlike all other kinds of meat animals (except poultry), there are more in Southern California than in the Central Coast Ranges and Valleys sub-region. This may be owing partly to the larger quantity of the sorghums and alfalfa grown in the southern sub-region, but probably the principal reason is the garbage supplied by Los Angeles City.[17] The total number of swine in the entire region on January 1, 1925, was only 325,000, which is about as many as in three average countries in Iowa, but by 1928 the number had increased to 500,000, according to the official estimates.

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[17] Prof. E. C. Voorhies, of the University of California, informs the writer that almost one-

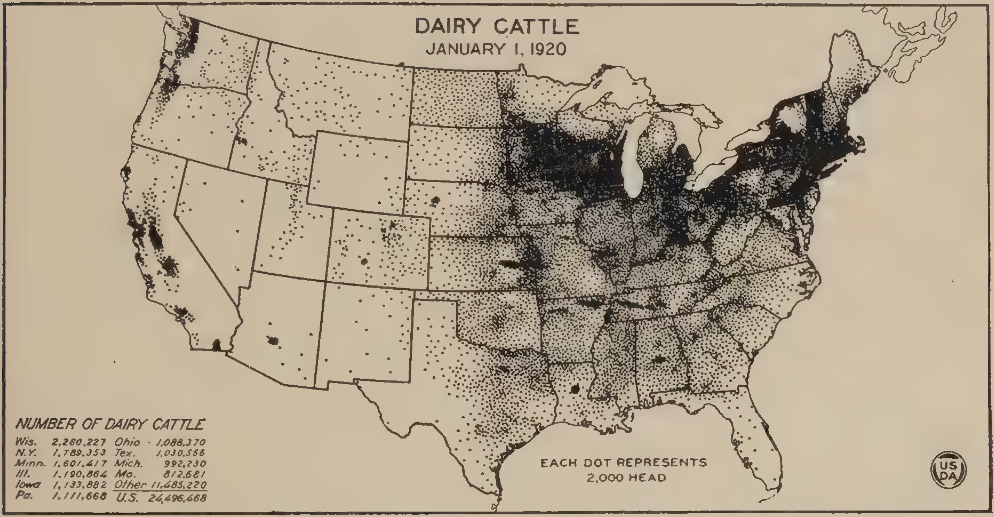

Figure 241.—California has become a great dairying state, though scarcely in the same class with New York, Wisconsin, and Minnesota. There were 500,000 cows milked in the Subtropical Crops Region in 1924, which, according to the Census, produced an average of 650 gallons per cow. This is a higher average than in any state except New Jersey. Although there were only 11 per cent more dairy cows in the region in 1924 than in 1919, the production of milk was nearly 25 per cent greater. More than half the dairy cattle in the region are in the Great Valley. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

The poultry industry, on the other hand, is as highly developed in the Pacific Subtropical Crops Region as in any other part of the United States, or of the world, for that matter. There were over 12,100,000 chickens in the region on January 1, 1925, and the farm value of the eggs produced in 1924 was over $30,000,000, while the value of the chickens raised was $12,000,000 more. The poultry industry ranks second to the dairy industry in value of products. Unlike all other farm animals, there are more chickens in the Coast Ranges and Valleys sub-region, and also in Southern California, than in the Great Valley. The most concentrated center of egg production in the United States, probably in the world, is the Petaluma district in the Sonoma Valley, near San Francisco. In this small town and environs there are probably 2,000,000 hens, practically all white leghorns, while in Sonoma County there were over 3,200,000 chickens on January 1, 1924 (Fig. 243). This is nearly three times as many as in any other county in the United States, except Los Angeles County, where there were about 1,800,000. These two counties had 5,000,000 chickens, or 40 per cent of the total in the entire region. There were 3,125,000 chickens in the Great Valley in 1924, nearly 5,500,000 in the Coast valleys, and 3,500,000 in Southern California. Although there are over a million people in the San Francisco Bay cities, and an-

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tenth of the hogs of California are on one ranch in San Bernardino County, fed almost exclusively on garbage.

other million in the Los Angeles district, the production of eggs now exceeds the domestic demand, and eggs are shipped as far east as the Atlantic Coast. The large production near shipping points combined with a splendid marketing organization enables Petaluma eggs to arrive in New York City in such fresh condition as to bring the highest prices.

The bee-keeping industry is also as highly, if not more highly, developed in California than in any other state. In production of honey California leads all the states, and was exceeded in number of hives in 1919 only by Texas and Tennessee (Fig. 244). The greatest production is in Southern California, but the San Joaquin Valley also produces large quantities. The bee industry is associated with the fruit industry, as the bees are needed to fertilize the blossoms of many trees; but on the other hand, the abundant fruit blossoms, as well as the alfalfa blossoms and the various wild flowers, also provide food for the bees. Many bee keepers live in cities or villages and have the hives scattered for miles around—in a remote corner of a farm, in a national forest, and even in the open desert. The production of honey in the region ranges normally between 10,000,000 and 15,000,000 pounds.

Although California has gone farther, probably, than any other state in adopting the farm tractor, horses and mules still ranked next to cattle in aggregate value in 1924. There were 300,000 in the Subtropical Crops Region on January 1 of that year, of which only 15,000 were under two years old. In 1910 there were nearly 40,000 colts of this age. In other words, the production of colts has almost stopped. About 55 per cent of the work stock (two years old and over) were in the Great Valley, and the remainder were equally divided between the Central Coast Ranges and Valleys and Southern California. But, less than half of the 26,300 tractors in the Region in that year were in the Great Valley, while over a third were in Southern California. Replacement of horses by tractors appears to be proceeding more rapidly in Southern California, where the farms are much smaller than in the Great Valley. This may be owing partly to the increasing number of farms in Southern California. The adaptation of the tractor to the small acreage of many truck and fruit farms has been remarkable.

The number of horses in the region declined about 22 per cent between 1920 and 1925, and mules 12 per cent. In 1929 the estimates of the U. S. Department of Agriculture indicate a further decrease since 1925 of 15 per cent for horses and 10 per cent for mules. How long this replacement of work stock by tractors and automobiles will continue cannot be foretold, but the very few colts being raised indicates that it will continue for several years at least.

SYSTEMS OF FARMING

In no other region in North America is agriculture so highly specialized as in the Pacific Subtropical Crops Region. The systems of farming are almost as numerous as the crops. However, it is possible to group these systems into eight classes as follows: (1) fruit and nut farming, (2) vegetable growing, (3) sugar beet and bean production, (4) grain farming, (5) hay production and dairying, (6) beef cattle ranching, (7) sheep grazing and fattening, and (8) poultry and egg production. This is an extraordinary number of major systems to be found in a region having only 122,000 farms, only one half as many as Ohio or Missouri.

Fruit farming should be further classified into citrus fruit orcharding, deciduous fruit production, grape growing, and nut farming. Citrus fruit orcharding is often more than a system of farming; it is a form of recreation and a manner of life for many growers. Over 22,000 farmers reported orange trees and 11,000 reported lemon trees in 1925, which gives an average of a little over 8 acres of oranges, but less than 4 acres of lemons, per farm reporting. In the Southern California counties, where the citrus production is very important, the average area of land per farm is over 100 acres, of crop land 42 acres; but the most frequent sizes of farms, according to the census, are those of 3 to 9 and of 10 to 19 acres, with farms of 20 to 49 acres almost as numerous. The farms average in value $300 per acre, but fruit farms usually range from $1,000 to $2,000 an acre. The value of orange orchards per acre is still greater. The average value of farms ranges from $25,000 to $70,000, varying with the county. A ten- to twenty-acre citrus orchard, therefore, is as large, measured in value, as a 100- to 200-acre farm in most parts of the Corn Belt. The amount of labor required for operation is also often as large, and at picking time may be larger. But, there is almost no livestock, except horses, and these are being replaced by tractors.

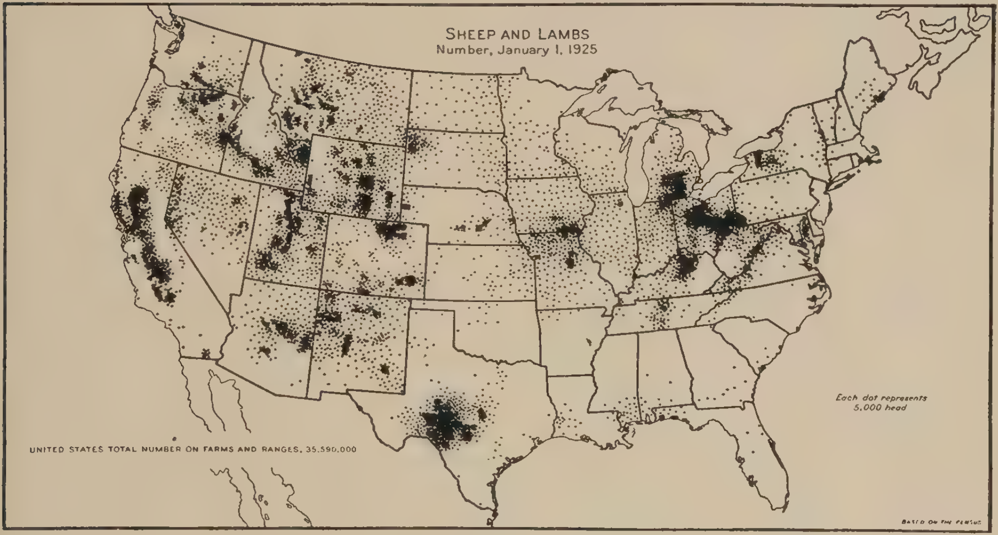
SHEEP AND LAMBS
Number, January 1, 1925
UNITED STATES TOTAL NUMBER ON FARMS AND RANGES, 35,590,000
Each dot represents 5,000 head
BASED ON THE CENSUS

Figure 242.—Nearly all the sheep in the Pacific Subtropical Crops Region were found by the Census enumerators in the Great Valley on January 1. In the summer season some of these sheep will be grazing in the mountains that almost surround the valley. The northern (Sacramento) portion of the Great Valley is one of the leading early lamb-producing areas in the United States. Compared with dairy cattle, sheep are relatively unimportant in California, being reported on less than 6,000 farms in the state in 1925, as compared with 60,000 farms for dairy cows. (Map from 1928 Yearbook, U. S. Dept. of Agr.)

The deciduous fruit farms average a little larger in area, but less in value than the citrus farms. In Santa Clara County, for instance, the most frequent sizes of farms are those of 10 to 19 and 20 to 49 acres, with an average of 25 acres of crops, of which probably 15 acres are fruit, mostly prunes, peaches, pears, and apricots, according to locality and individual preference. The average value of farms in 1925 was $25,000, but the orchard acreage would average nearly $1,500 an acre. The vineyard farms are still larger, commonly 20 to 49 acres in size, but average in value only $15,000 to $20,000. In the typical fruit farm most of the land is in fruit, except that occupied by the house and a small barn or garage. The nut farms vary greatly in area, but would average, probably, about the same acreage and value as the deciduous fruit farms.

Vegetable production, like fruit production, is generally a specialized system of farming. The average area per farm is from 15 to 40 acres, varying with locality, and the average value of the farm is $10,000 to $25,000. The average area of cantaloupes per farm in California in 1924 was 17 acres; of lettuce, 12 acres; of potatoes, 10 acres; and of tomatoes, 7 acres. Many farms may grow two or more vegetables and some farms have hundreds of acres of truck crops and may use a half dozen tractors. The production of lettuce and cantaloupes especially has become highly mechanized, and some growers have as high as 2,000 and even 3,000 acres of these crops. Nevertheless, the amount of labor employed per acre is even greater for many vegetable crops than for fruit crops.

The sugar beet and bean farms average much larger, the area of sugar beets per farm in the state being nearly 100 acres, and of beans over 40 acres. In Ventura County, where both these crops are important, the average area of crop land per farm is 90 acres, and the average value of land and buildings per farm is $70,000. Some farmers produce both sugar beets and beans. The sugar beet acreage has declined greatly in recent years, owing in large part to the low price of sugar.

Grain farming is the most extensive system of crop farming in the region. The grain is mostly non-irrigated and is now grown on soils less highly esteemed for fruit and vegetables, or for which water is unavailable. The average area of wheat per farm reporting in 1924 was about 150 acres, and of barley over 150 acres. Some of the grain farms contain over 1,000 acres. These farms are usually devoted very largely to grain, but often fruit also is grown.

The major dairying area is the Great Valley, with secondary areas in the Los Angeles and San Francisco Bay districts (Fig. 241). Hay and dairying are usually associated in California, as they are in the Northeastern States. The average area in 1924 of alfalfa per farm was 24 acres; of grain hay, 32 acres. The alfalfa is cut every six to ten weeks throughout the year, but the grain hay only once, as the small grains are annual plants. Some farmers grow both hays, but probably not a majority. The average hay farm would consist of 25 to 40 acres of hay, and many would have as much or more grain. The average number of cows milked per farm having cows is 9, but the commercial dairy farms would probably average twice as many cows per farm as this. Nearly half of the milk produced in the region is separated and the butterfat sold to butter factories, while less than a third is sold as market milk, mostly for domestic use. The remainder is sold as cream, made into ice cream, cheese, condensed milk, and other products, or used on the farm. More generally, perhaps, than in any other part of the United States, dairying in California is a year-round industry. The production of milk per cow in 1924 was 630 gallons, according to the Census—higher than in any other state, except New Jersey. The year 1924 was very dry and probably 700 gallons per cow (6,000 pounds) is nearer the average.

Unlike dairying, which is primarily an irrigated land industry, beef cattle ranching is found largely on the unirrigated lands, both in the Great Valley and in the Central Coast Area. Many of the cattle men have hundreds of head of stock that graze over thousands of acres, but the average number of beef cattle per farm reporting was only about 80 in 1925. This is not enough to provide a comfortable living, of course, in the average year. Although the cattle are mostly grazed in the hills and dry valley lands, especially during the moist winter period, they are likely to be moved into the irrigated portions of the valleys for fattening on alfalfa and grain prior to slaughter. Many cattle ranches have some irrigated land, and most of them grow 50 to 100 acres or more of dry-land grain, largely barley.

Sheep production is, perhaps, even more dependent on grazing the dry lands. The sheep industry of the region is almost confined to the Great Valley and the margins of the Sonoma Valley (Fig. 242). In summer, however, many of the sheep will be found grazing in the mountains. In the winter, when the census was taken, the sheep were nearly all in the valley feeding on alfalfa and grain, and also on the stubble fields and natural pastures, which have turned green after the winter rains. Sheep farming, in the past, was more pastoral than agricultural, and a sheep man might have an "outfit" of a wagon, tent, and other equipment, rather than a farm. However, the development of the winter lamb industry as well as the need of having assured feed and the requirement for grazing in the national forests that permittees have improved ranch property, has caused the sheep industry to become sedentary and a sheep farm in the Sacramento Valley is now likely to consist of 50 to 100 acres or more of grain, and a similar acreage of alfalfa or grain hay, while commonly additional feed is purchased. There were only 4,000 farms in the region reporting sheep in 1925, and the average number per farm reporting was only a little over 500 head. The typical sheep "outfit," however, has from 1,000 to 2,000 head in a band, and may include several bands.

The poultry industry, unlike the sheep industry, is a very intensive type of farming, which has developed to an extraordinary degree in Sonoma and Los Angeles counties and to a less extent in other parts of the state. There were somewhat over 5,000 farms in each of these counties that reported chickens in 1925, and the average number of chickens per farm was over 300 in Los Angeles County, and over 600 in Sonoma County. Many farms in both counties, however, had only a few chickens, the typical poultry farm having from 2,000 to 4,000. The poultry farms are like manufacturing plants in that they occupy only a few acres of land and buy most of the feed used (Fig. 243). The days are lengthened in winter by electric lights so the hens will eat more feed and thus be able to produce more eggs. Trap nests are commonly used and egg laying records kept for the better hens as a basis of breeding up the stock. Probably no farm industry has utilized more fully the discoveries of science and various devices and inventions than the poultry industry, especially in California, and no farming industry in the region has made more rapid progress.

In no other part of the world, probably, is agriculture so specialized and so diverse as in the Pacific Subtropical Crops Region. Every grain crop reported by the Census as grown anywhere in the United States is also reported in California; every kind of hay; every vegetable grown for sale, except horseradish; every fruit, except kumquats, pineapples, mangoes, sugar apples, and sapodillas; every other crop, except sugar cane, maple trees tapped for sugar, castor beans, chufas, ginseng, peppermint, and teasels. On the other hand, it is the only state to report cassava and citrons. No state compares with it in variety of crops.

Agriculture in the valleys of California is characterized by the Mediterranean fruits, but also, locally, by cotton from Mexico, the grain sorghums from Africa and India, rice from the Orient, and sugar beets from Northern Europe. Agriculture in the mountains is based on timothy and clover hay, as in the northern United States, and along the cool coast apples and beans are grown, as in Michigan and New York. Likewise, with livestock—beef production, dairying, wool and lamb production and, outstandingly, egg production and honey production—all are highly developed. Only in the production of pork and lard does California fail to occupy a conspicuous place. This diversity is owing partly to the variety of climatic conditions, but the diversity of the agriculture exceeds the diversity of the climate. Driving along a road in Southern California, it is quite likely there will be found in succession an alfalfa and dairy farm, a walnut orchard, an orange grove, a poultry farm, and a truck farm.

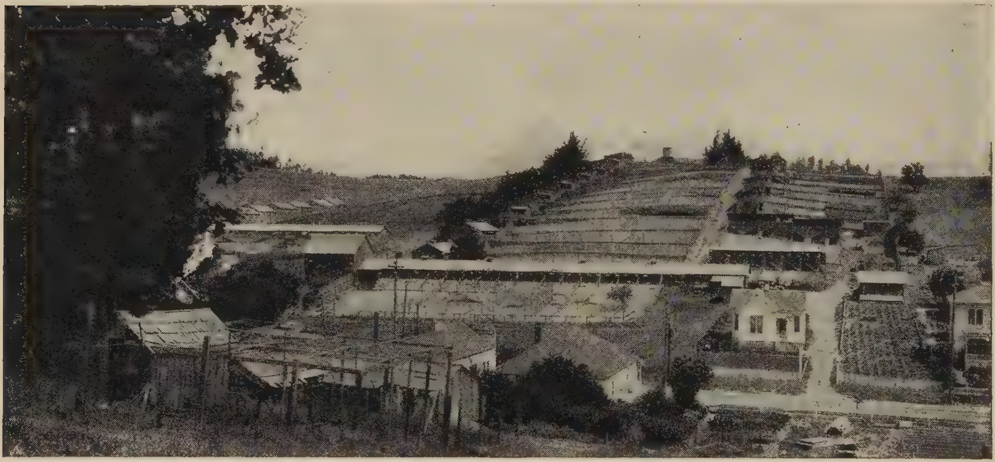

FIGURE 243.—A poultry breeding plant operated by one of the leading hatcheries in the Petaluma district. Cockerels produced on this farm are used to head up the flocks that supply the hatchery with eggs. (Photo from Dairy and Poultry Division, U. S. Bur. of Agr. Economics.)

This extraordinary specialization in intensive systems of farming involves a large expenditure for labor and, in less degree, for feed. Far more money is paid as wages to farm labor in California than in any other state—about as much as Iowa, Missouri, Kansas, and Nebraska combined (Fig. 245). There was also a greater expenditure for feed in 1924, according to the census, than in any other state, except New York. The average expenditure for labor on the 85,000 farms reporting such expenditure was about $1,250 per farm; and for the 80,000 farms reporting expenditures for feed the average was $660 per farm. Only Arizona had any comparable expenditure per farm for labor, and only Massachusetts, Rhode Island, and New Jersey had a greater expenditure per farm for fertilizer and manure. Sixteen thousand farmers, mostly citrus growers and truck growers, reported an expenditure for fertilizer of $8,371,000 in 1924, an average of $525 per farm.

Agriculture in California is commercialized to a greater extent, probably, than in any other state. Being commercialized, it is organized undoubtedly to a greater extent than in any other state. This organization is on a commodity basis, but there is also a splendid State Department of Agriculture, a State Research Council, and a State Development Board, as well as highly efficient chambers of commerce in the principal cities. Moreover, the University of California is the largest state university in the nation, and it has a larger research staff in agriculture than that in any other state. All of these organizations pull together, and they are accomplishing great tasks.

SIZE AND TENURE OF FARMS

The Pacific Subtropical Crops Region possesses both the largest and the smallest farms in the nation, measured by area; and probably measured by value of products also. The large farms can be traced to the old Spanish land grants made when California was a Spanish colony. After the acquisition of California from Mexico, many of these estates were purchased from the Mexican owners by American speculators, and operated for a longer or shorter period as cattle ranches. Most of these "ranches" and mission properties have been divided into farms and sold, but a few remain, and some of these large estates are highly developed. The Census of 1925 enumerated 3,233 farms in the Subtropical Crops Region exceeding 1,000 acres in area, and of these nearly 500 contained 5,000 acres or more. There are several estates that exceed 100,000 acres.

On the other hand, nearly two-thirds of the farms in the Region contain less than 50 acres, a proportion that is higher than in any other agricultural region.[18] The proportion is about 75 per cent in Southern California, where most of the farms are fruit, vegetable, or poultry farms, and is only a little over 60 per cent in the Great Valley, where, in addition to the fruit and vegetable farms, there are many hay and dairying farms, cattle and sheep ranches. Both in number and in proportion, large farms are most numerous in the Great Valley and least numerous in Southern California, as is shown in Table II.

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[18] In Southern New England and New Jersey, also in the states south of the Potomac and Ohio rivers, about half of the farms have less than 50 acres of land; but in New England many of these farms are residences of city workers from which the products are of little value, while in the "Old South" probably most of these small farms are holdings of croppers, who are paid wages by the land owners in the form of a share of the crops, and hence are classified by the Census as tenant farmers.

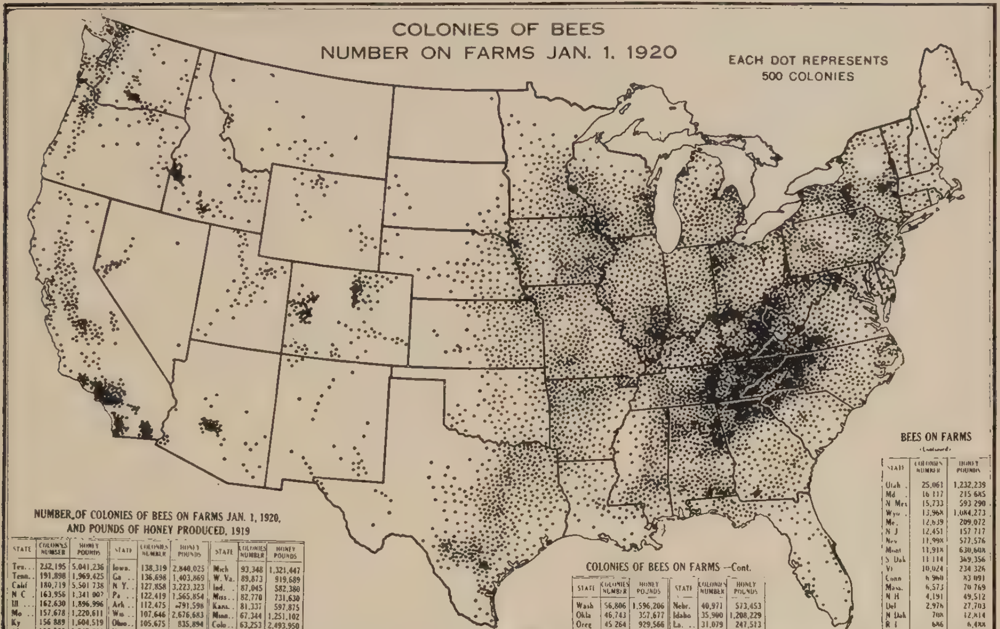
Although two-thirds of the farms are under 50 acres in area, these farms include only about 5 per cent of the farm land and less than 20 per cent of the crop land. Nearly 25 per cent of the crop land is in farms of 50 to 175 acres in area, 20 per cent more in farms of 175 to 500 acres and 35 per cent in farms of over 500 acres in area. Over half the crop area, therefore, is in what might be called large farms (over 175 acres in area). Numerically, California is a state of little farms, but in productivity the big farms contribute probably as much as the little farms and are worth almost as much. Perhaps nowhere is there a better adjustment of the size of the farm to the varying capacities and abilities of farm operators.

TABLE II

PACIFIC SUBTROPICAL CROPS REGION FARMS CLASSIFIED BY AREA, 1925

Sub-Region	*Under 20 Acres*	*20 to 49 Acres*	*50 to 99 Acres*	*100 to 174 Acres*	*175 to 259 Acres*	*260 to 499 Acres*	*500 to 999 Acres*	*Over 1,000 Acres*	*Total*
Great Valley	13,319	22,683	8,135	5,102	1,918	2,695	4,503	1,802	60,157
Coast Valleys	14,220	6,176	3,185	2,431	1,053	1,539	2,385	936	31,925
Southern California	19,815	6,670	2,527	2,291	869	1,208	1,814	495	35,689
Total in Region	47,354	35,529	13,847	9,824	3,840	5,442	8,702	3,233	127,771

The 47,000 farms in the Subtropical Crops Region under 20 acres in area (over one-third of all farms), average about 6 acres in crops, and less than 9 acres in all. They had an average value of land and buildings in 1925 of $10,000, of which the land constituted $7,800 and the buildings $2,200. The principal building is the house, which is typically a one-story "bungalow" of 3 to 6 rooms, and as the temperature drops below freezing only for an hour or two on an occasional winter morning, and the people live largely out of doors, the house need not be very well built. The 36,000 farms of 20 to 50 acres in area average 21 acres in crops and 30 acres in all, have an average value of $16,000, of which the buildings account for only $2,200—the same as on the farms under 20 acres. It will be noted that the value of the land per acre is only about 60 per cent as great as for the smaller farms. The 24,000 farms of 50 to 175 acres in area average 60 acres in crops and 100 acres in all, are worth on the average $26,400, but the farm buildings only $2,800. Finally, all the farms over 175 acres in area, about 21,000 in number, average 160 acres in crops and $61,000 in value, of which buildings account for $4,500. These figures make clear the small investment in farm buildings in the Region, in barns as well as houses, and the very great investment in land. The buildings represented only 12 per cent of the joint value of land and buildings in 1925. The average value of the land per farm is greater than in any other state, and is approached only by Iowa, where the crop acreage per farm is over twice as large. It would seem on the surface that the peculiar climatic conditions have given the land almost a monopoly value, but it may appear on further investigation that irrigation works and orchard development have cost almost as much as the present value of the land.


COLONIES OF BEES
NUMBER ON FARMS JAN. 1. 1920
EACH DOT REPRESENTS 500 COLONIES

NUMBER OF COLONIES OF BEES ON FARMS JAN. 1, 1920, AND POUNDS OF HONEY PRODUCED, 1919

STATE	COLONIES NUMBER	HONEY POUNDS	STATE	COLONIES NUMBER	HONEY POUNDS	STATE	COLONIES NUMBER	HONEY POUNDS
Tex. . .	232,195	5,041,236	Iowa.	138,319	2,840,025	Mich	93,348	1,321,447
Tenn. .	191,898	1,969,425	Ga . .	136,698	1,403,869	W. Va.	89,873	919,689
Calif	180,719	5,501 738	N. Y. .	127,858	3,223,323	Ind. .	87,045	582,380
N C .	163,956	1,341 002	Pa . .	122,419	1,565,854	Miss. .	82,770	731,630
Ill. . . .	162,630	1,896,996	Ark . .	112,475	791,598	Kans. .	81,337	597,875
Mo . .	157,678	1,220,611	Wis . .	107,646	2,676,683	Minn. .	67,344	1,251,102
Ky	156 889	1,604,519	Ohio. .	105,675	835,894	Colo . .	63,253	2,493,950
Ala .	153,766	1,347,644	Va. . .	104,267	1,267,300	S.C . .	58,028	441,684

COLONIES OF BEES ON FARMS—Cont.

STATE	COLONIES NUMBER	HONEY POUNDS	STATE	COLONIES NUMBER	HONEY POUNDS
Wash	56,806	1,596,206	Nebr.	40,971	573,453
Okla	46,743	357,677	Idaho	35,900	1,208,229
Oreg	45 264	929,566	La. . .	31,079	247,513
Fla	41,237	962,488	Ariz . .	28,174	926,621

BEES ON FARMS
(Continued)

STATE	COLONIES NUMBER	HONEY POUNDS
Utah .	25,061	1,232,239
Md .	16 117	215 685
N Mex	15,733	593 290
Wyo .	13,968	1,084,273
Me.	12,639	209,072
N J	12,451	157 717
Nev	11,998	577,576
Mont	11,918	630,608
S Dak	11 114	369,356
Vt	10,024	234 326
Conn	6 960	83 091
Mass.	6,573	70 769
N H	4,191	49,512
Del	2,976	27,703
N Dak	708	12,814
R I	686	6,488
U S . .	3,467,396	55,224,061

FIGURE 244.—Although California had less than a third as many hives of bees as the southern Appalachian center shown on the map, extending from eastern Kentucky to northern Georgia, the California bees produced more honey in 1919 than the bees in the eastern area. The average production in California was over 30 pounds per hive, in the Appalachian area less than 10 pounds. California is the leading state in honey production. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

Unlike most regions where land values are high, there are few tenant farmers in the Pacific Subtropical Crops Region—less than 14 per cent. For the United States as a whole the average in 1925 was 38.6 per cent. The crops grown and the specialized systems of farming help to explain the low percentage of tenancy. A fruit orchard can seldom be safely entrusted to a tenant. He might do more harm in one year than the owner could repair in 20 years. Moreover, the prices of the products, and consequently the returns, fluctuate widely and not infrequently result in serious losses, as well as in extraordinary profits. Likewise, with dairying and egg production, technical experience is required as well as heavy investment on the part of the farmer. This is equally true of the beef cattle ranches. These systems of farming everywhere in the United States have a low percentage of tenancy. When an owner cannot operate such a farm himself, he often prefers to hire a manager, in order that he may continue to exercise a large measure of control. There were over 5,500 farms operated by managers in the Region in 1925, or 4.5 per cent as compared with 0.6 per cent for the United States.

Nearly half of the farms operated by owners are mortgaged (no data for tenant farms), and the debt is about one-third of the value of the farms. This is a larger proportion of the farms, but a lower ratio of debt to value than for the United States as a whole.

In brief, the Pacific Subtropical Crops Region is characterized by very valuable farms, mostly small, but many large and some very large, in which most of the investment is in the land and the trees on it. Nearly half of the farms are mortgaged. Most of the farmers live in small, cheaply built houses, which, however, are commonly provided with modern sanitary and labor saving devices. Only the dairy farms and cattle ranches have barns of any size—there is little need for them.

THE PEOPLE

California has been the melting pot of Americans and, in addition, has tried to fuse into its citizenship a large assortment of aliens. More people living in California in 1920 were born in other states than were born in California—nearly 1,400,000 in all. About 80,000 of these residents of the state were born in New England, 100,000 in New York, 70,000 in Pennsylvania, 90,000 in Ohio, 60,000 in Indiana, 140,000 in Illinois, 50,000 in Michigan, 45,000 in Wisconsin, nearly 90,000 in Iowa, 105,000 in Missouri, over 60,000 in Kansas, and 50,000 in Texas. Kentucky, Tennessee, Minnesota, Nebraska, and Colorado contributed between 20,000 and 40,000 each. Only the old Cotton Belt States east of Texas are poorly represented. There are far more emigrants from other states living in California than is the case in any other state. Southern California in particular has been populated largely by these emigres. Los Angeles and other cities have flourishing Ohio, Illinois, and Kansas societies, which meet monthly, quarterly, or annually for a social evening. The California-born, not to be outdone, likewise have a native sons' society of which they are quite proud.

On the other hand, a smaller proportion of the people born in California have moved to other states to live (10 per cent) than is true of any other state. Not only the climate, which encourages outdoor life throughout the year (though it becomes to some rather monotonous) and lowers the cost of living, but also the high wages for manual labor and the excellent facilities for education and recreation, have been important factors in holding Californian-born at home.

California early adopted the automobile and took the lead in the building of good roads. It has a larger mileage of hard surfaced roads per thousand population than any other state, except Delaware and Nevada.[19] It was one of the first states to use and improve the farm tractor. The famous "caterpillar" type was invented and developed in California. There are now more tractors per 1,000 horses and mules in California than in any other state. The farmers of California were the first to organize successful coöperative marketing associations, and now probably half of the fruit of the state and many other agricultural products are sold through coöperative organizations. These maintain efficient agencies not only in many eastern cities, but also in Europe and Asia. The proportion of the farm houses having water piped into the house is higher in California than elsewhere in the United States except in New England; and the proportion having radio outfits is also higher than elsewhere, except in a few New England and Corn Belt states.

This spirit of progress is shown also in the State's educational and research institutions, as will be noted later. It is this spirit of the people fully as much as the natural resources, which are not more abundant than elsewhere, that has held the Californians at home and attracted immigrants not only from other states, but also from the ends of the earth.

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[19] U. S. Bureau of Public Roads figures for 1928 for bituminous Macadam, sheet asphalt, bituminous concrete, Portland cement, vitrified brick, and block asphalt, wood and stone. California has 5,600 people to the mile of such roads.

NATIONS AND RACES

Over 750,000 residents of California (22 per cent) were foreign born in 1920. Nearly 60,000 were born in Canada, 80,000 in Great Britain, and over half as many more in Ireland. Scandinavia contributed over 60,000, Germany and Austria 80,000, France 20,000, and Switzerland 16,000. Italians numbered 90,000, Portuguese 25,000, plus 9,000 from the Azores, Spaniards 11,000, and Greeks 10,000. There were 27,000 Russians in the state, 7,000 Poles, 7,000 from Jugoslavia, and 5,000 from Hungary, while Armenia and Syria contributed 7,000. From the Far East came 2,000 from India, 4,000 from the Philippines, 20,000 from China, and over 50,000 from Japan. In 1920 Mexico had contributed 90,000. The number of Mexicans in California is now much larger, probably 400,000 to 500,000, as 65,000 Mexican children were enrolled in the public and Catholic schools in 1927.[20] Many of these Mexicans, of course, were born in the United States. Central and South America have sent 4,000 people to live in California, Australia 4,000, Hawaii 8,000, and other islands of the Pacific (Samoa and Tahiti) nearly 2,000, while the West Indies contributed 1,300, and Africa 700.

As these immigrants have risen in economic condition, other laborers willing to do manual work and at a lower wage, have been encouraged to come to the state. Not only Mexicans, but also Philippinos, have been coming in large numbers, many of them without families, and serious social problems are developing.

Nevertheless, California is the new New England. From the days of the Gold Rush and the "Forty Niners" until the present, the people of New England ancestry, not only from New England, but also from New York, Michigan, northern Ohio and Illinois, Iowa, Nebraska, and Kansas have sought their fortune or freedom from cold winters in the balmy or blistering climate of California. The climate, the magnificent scenery, and the charming Spanish tradition have also attracted many artists, authors, and other people of culture to the state, as well as retired business and professional men. Of the 1,681 people living in California listed in "Who's Who" (California ranks fifth among the states), 1,246, or nearly three-fourths, were born outside the state, mostly in New England, the other northeastern states, and the north central states.

EDUCATION

Such people are interested in schools and the amenities of modern life. The California public school system ranks among the best of the state school systems. Thirty public high schools and three private junior colleges now offer instruction equivalent to that in the freshman and sophomore years in the universities, and both of the leading universities in the state (Stanford and the University of California) are considering doing away with these years in their courses of study and combining the

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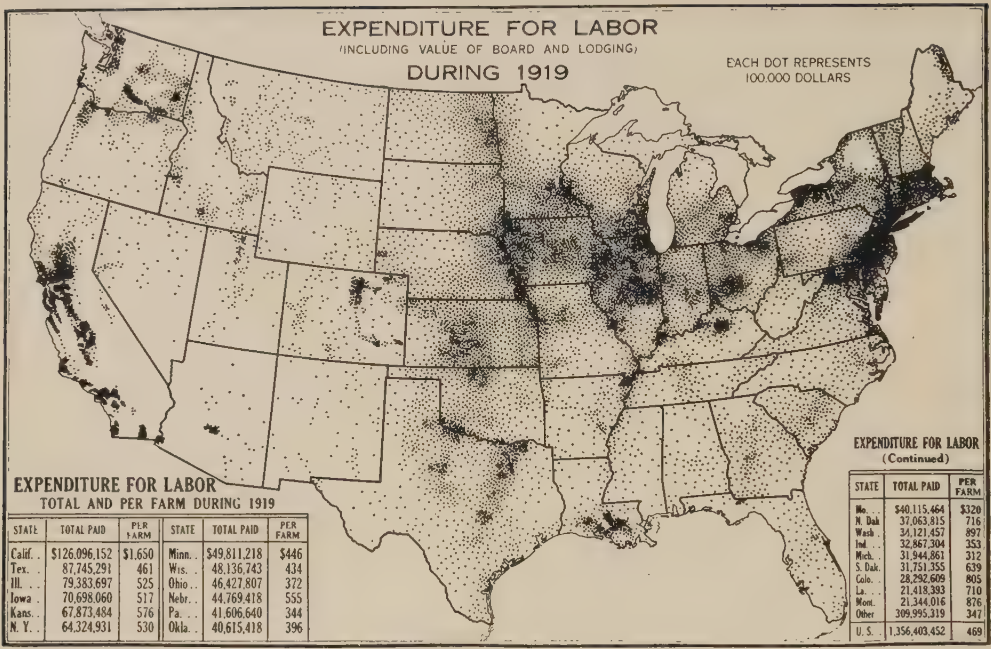
[20] Taylor, Paul S., "Mexican Labor in the United States, Racial School Statistics, California, 1927." University of California Publications in Economics: Vol. 6, no. 4, Berkeley, 1929.


EXPENDITURE FOR LABOR
(INCLUDING VALUE OF BOARD AND LODGING)
DURING 1919
EACH DOT REPRESENTS 100,000 DOLLARS

EXPENDITURE FOR LABOR
TOTAL AND PER FARM DURING 1919

STATE	TOTAL PAID	PER FARM	STATE	TOTAL PAID	PER FARM
Calif. .	$126,096,152	$1,650	Minn. .	$49,811,218	$446
Tex. .	87,745,291	461	Wis. .	48,136,743	434
Ill. . .	79,383,697	525	Ohio . .	46,427,807	372
Iowa .	70,698,060	517	Nebr. .	44,769,418	555
Kans. .	67,873,484	576	Pa. . .	41,606,640	344
N. Y. .	64,324,931	530	Okla. .	40,615,418	396

EXPENDITURE FOR LABOR
(Continued)

STATE	TOTAL PAID	PER FARM
Mo. . .	$40,115,464	$320
N. Dak	37,063,815	716
Wash .	34,121,457	897
Ind. . .	32,867,304	353
Mich. .	31,944,861	312
S. Dak.	31,751,355	639
Colo. .	28,292,609	805
La. . .	21,418,393	710
Mont.	21,344,016	876
Other	309,995,319	347
U. S. .	1,356,403,452	469

FIGURE 245.—The expenditure for farm labor is greater in California than in any other state. It was greater in 1924 than in New England, New York, and New Jersey combined, or in Ohio, Indiana, Illinois, and Missouri considered jointly. The average expenditure per farm reporting was $1,650 in 1919, including value of board and lodging, and $1,240 cash per farm in 1924. In most states the average expenditure for labor per farm is not half so great. (Map from 1921 Yearbook, U. S. Dept. of Agr.)

junior and senior years of work with the graduate years in courses largely of professional character.

The University of California is the largest state university in North America, both in enrollment of students (19,000 in residence at Berkeley, Davis, and San Francisco, and at the Southern Branch in Los Angeles), and in expenditure of funds ($12,614,000 for all purposes in 1927–1928). The enrollment at Stanford University is about 4,550, at the University of Southern California is 11,100, and at other colleges and universities 11,000, plus 8,400 in junior colleges, a total of 54,000 students in the higher institutions of the state. This is a larger number of students than in the universities and technical schools of Great Britain, which has a ten-fold greater population.

For every 100 children who enter the first grade of school, 82 complete the elementary school, 79 enter high school, 35 graduate from high school, 27 enter college or university (including students from other states, but excluding California citizens in school outside the state), and 7 graduate from college or university.[21] These proportions are a half higher than in the United States as a whole. The number of students in graduate or professional schools in California is about equal to the number graduating from college. However, several graduating classes may be represented in these graduate schools, and some graduate students come from other states.

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[21] These data on university and school enrollment in California were courteously provided by Dr. Frank M. Phillips, Statistician, U. S. Bureau of Education.

The proportion of the children 7 to 13 years of age attending school in California in 1920 was 93.7 per cent, which was 3 per cent higher than in the United States as a whole, but was lower than in 22 states, located mostly in the Northeastern and the Rocky Mountain regions. The large proportion of Mexican and other foreign immigrants and the opportunity for agricultural work during the winter accounts in large measure for this relatively low school attendance. On the other hand, the proportion of persons 18 to 20 years of age attending school was higher in California (21.9 per cent) than in all the other states except four—Oregon, Nevada, Utah, and Idaho. It was twice as high as in Pennsylvania or Louisiana, and almost twice as high as in New York, Illinois, Michigan, or Georgia.

Illiteracy

Nearly four per cent of the people of California in 1920 were unable to read or write. But for the native whites of native parentage the proportion was only 0.4 per cent; for those of foreign parentage 0.5 per cent, while for the negro it was 5.6 per cent and for the foreign-born whites it was 10.7 per cent. Although there were 17 states having a lower illiteracy rate than California, there were only three states (Massachusetts, North Dakota, and Washington) for which the rate was lower for native whites of native white parentage. One of the great tasks of the California school system is to educate the children of its foreign-born residents. This is especially difficult in Southern California, where Mexican children constituted, in 1927, about 16 per cent of the total enrollment in the elementary schools, and Japanese children 2.2 per cent. However, the Japanese children are no problem, for they are usually bright students and anxious for an education.

RELIGION

Over 1,500,000 people in California were members of a church in 1926, or about 40 per cent of the total population. Of the adults nearly half were church members. About one-third of the church members 13 years of age and over were Catholics (510,000), and nearly two-thirds (158,000) of those under 13 years of age. As there are 65,000 Mexican children enrolled in the public and Catholic schools, it appears probable that a large proportion of this juvenile Catholic membership is Mexican.

The leading Protestant denomination is the Methodist, whose membership totaled about 150,000 in 1926. The Presbyterians are two-thirds as numerous, while the Protestant Episcopalians and the Baptists each number about half as many. There are nearly 50,000 Disciples of Christ and 43,000 Congregationalists; also nearly 40,000 Lutherans of various kinds and 26,000 Mormons. Adventists numbered 20,000 and Christian Scientists 16,000. The membership of Jewish congregations numbered 123,000. There are 50 other religious denominations listed in the Census, besides 41 churches classified under the heading "all other denominations," but none of these had over 10,000 members.

It is to be expected that where a people are gathered from the ends of the earth there will be great diversity of religious faiths, but doubtless the number in California is augmented by the partial idleness of the people of wealth and culture who have retired to California and find rest or recreation in some new or novel belief. In Los Angeles, as in ancient Athens, there are monuments to the unknown God, and if Saint Paul should visit this great city, he would find that many of its people, like the Athenians of old, are very religious.

TREND OF POPULATION

The growth of population in California has been extraordinarily rapid. From 92,600 people in 1850 to 1,485,000 in 1900 and 3,427,000 in 1920, the rate of gain exceeded 40 per cent each decade, except from 1890 to 1900. Only two states had a more rapid rate of gain than California between 1910 and 1920, Arizona and Montana, and these are states of relatively small population.

The growth of the farm population has likewise been rapid right up to the present, and in this regard California is almost unique among the states. Statistics of farm population were secured for the first time by the census of 1920, but the total population, total families, and number of farms, or farmers, are available since 1850; also rural population and rural families can be calculated. By calculating the average size of the rural family for 1850 to 1880, and multiplying the number of farms by rural population per family, it is possible to approximate closely the changes in farm population during the past 75 years. These changes are compared with the changes in total population in Table III.

It will be seen that the farm population increased at a faster rate than the total population from 1870 to 1900, but that between 1900 and 1910 the farm population increased only about 20 per cent, as compared with 60 per cent increase in total population. From 1910 to 1920 farm population increased about 24 per cent, while total population increased 44 per cent. From 1920 to 1925 the farm population increased probably between 13 and 15 per cent, which is very remarkable, not only because of the high rate of increase, but also that any increase should have occurred while all other states except those in Southern New England, South Dakota, Nevada, and Washington were experiencing a decrease. For the United States as a whole, the decrease in farm population in the five years was over 6 per cent.

The importance of immigration to the progress of population in California is indicated by the fact that less than half of its people were born in the state. The trend of the birthrate suggests that this proportion may be even greater in the future. The births in 1928 had fallen nearly to 18.3 per thousand population, which was considerably lower than the average for the nation. On the other hand, the death rate was higher than in any other state, except New Hampshire. This is not owing to unhealthful conditions, the infant mortality being among the lowest in the nation, but to the large number of old people and invalids who have moved to the state to spend their declining years. More than 6 per cent of the people of the state were over 65 years of age, according to the 1920 census, as compared with 4 per cent for the entire United States; while only 8 per cent were under 5 years of age, as compared with an average of nearly 11 per cent for the nation as a whole.

Between 1924 and 1928 the birthrate in California fell from 22.2 to 18.3. Since a birth-rate of about

16.6 is necessary to maintain in a stationary condition a population which is not being augmented by immigration, (and which has an average age at death of 60 years, as in California) it appears that after the present generation of children reach maturity, if not before, California will be dependent on immigration into the state for any increase of population. Indeed, with a birth-rate already lower than that of France, the state may soon (in 20 to 30 years) be dependent on other states or foreign countries to keep its population from declining.

In this respect California is not different from most other states, except in degree. The birth-rate in nearly all parts of the United States, and also in Northern Europe, has declined very rapidly since 1921, but in California the decline has been exceptionally rapid and has reached a lower point than in most states.

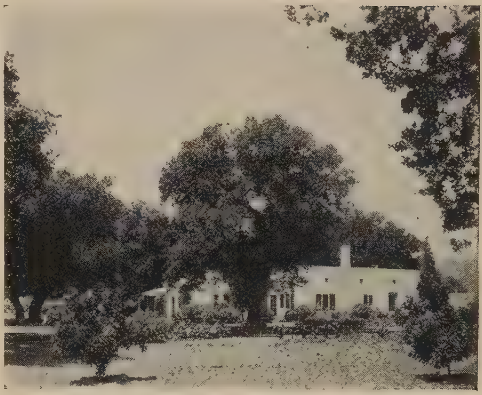

FIGURE 246.—A typical California home, one story and close to the ground because the rainfall is light and the soil is dry, ventilating windows beneath the roof because the sun is hot, thick walls because the summer days often are warm, placed among the live-oaks because of the shade and the beauty, young orange trees in the foreground because the winters are mild, hills in the background because there is almost no land in the Pacific Subtropical Crops Region more than a few miles (an hour's auto ride) from the mountains—in all a delightful place to spend the winter, the vacation days, and the declining years of life. Particularly is this true of the coast for a few miles back from the ocean, where it is usually cool in summer as well as in winter. (Photo from Los Angeles Chamber of Commerce.)

In North America there are less than 150,000,000 people, while across the Pacific, in the Orient, there are probably 1,000,000,000 people. Yet, the area of land cultivated and the aggregate agricultural production is similar in magnitude in North America and the Orient, and likewise the

TABLE III

CALIFORNIA—TOTAL POPULATION AND ESTIMATED FARM POPULATION, 1850–1924

	*Population**						*Estimated Farm Population*	
Year	Total	Per Cent of Increase	*Total Number of Families**	*Total Population per Family†*	*Rural Population per Family‡*	*Number of Farms**	Total§	Per Cent Increase
1850	92,597	....	24,567	3.77	3.16	872	2,756	....
1860	379,994	310.4	98,767	3.85	3.61	18,716	67,565	51.6
1870	560,247	47.4	128,752	4.35	4.08	23,724	96,794	43.3
1880	864,694	54.3	177,508	4.87	4.62	35,934	116,015	71.5
1890	1,213,398	40.3	245,710	4.94	4.73	52,894	250,189	50.7
1900	1,485,053	22.4	341,781	4.35	4.26	72,545	309,042	23.5
1910	2,377,549	60.1	563,636	4.22	4.21	88,197	371,309	20.1
1920	3,426,861	44.1	900,232	3.81	3.91	117,670	460,090‖	23.9
1925	....	....	....	....	3.89¶	136,409	531,008**	15.4††

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* As reported by the Census.

† Total population divided by number of families.

‡ Total population of state less population in places of 2,500 people and more, divided by total families in state less families in places of 2,500 and more.

§ Number of farms multiplied by persons per rural family; probably not quite large enough, except in 1925, as farm family is doubtless slightly larger than rural family, but fairly comparable from 1850 to 1920.

‖ The census figure is 516,770, but this includes an unknown number of farm laborers not living on farms nor in incorporated places.

¶ Farm population divided by number of farms, as reported by the Census.

** Population living on farms January 1, 1925, according to the Census.

†† Only a five-year period; but the figure is probably a little too large, owing to the farm family in 1920 being slightly larger, doubtless, than the rural family.

potentially arable land, 1,500,000,000 acres, more or less, in each continent. With such a difference in population pressure, a difference that is likely to increase rather than diminish, it would seem that the only reasonable alternative to the movement of population from Asia to America is the movement of food and other agricultural products from America to Asia, and the acceptance in return of industrial commodities. The inter-relation of the Pacific Peoples is the great problem of the world, and in its solution American farmers may find ultimately the solution of some of their most difficult problems also.

THE FOREST OF DEAN IN GLOUCESTERSHIRE

E. Muriel Poggi

Geographer, University of Illinois

THE Forest of Dean is the name given to the part of Gloucestershire situated in the angle formed by the river Wye and the course of the lower Severn. It was once an important royal forest and it is underlain by a coalfield bearing the same name. It was the accepted opinion for many years that the South Wales and Forest of Dean Coalfields were originally united. Folding from the north and south took place in late Carboniferous times and gave the basin-like form to the two coalfields, and at a later period denudation along the Usk anticline separated the two fields. The area is formed almost entirely of Carboniferous rocks enclosing the Coal measures of the Forest (Figs. 1 and 3). It is doubtful if there is a perfect coal basin, forming a complete industrial unit, in such a small area, to be found anywhere else. The small size (roughly 9 x 12 miles) has made it possible to make a detailed study of the relief and structure, to visit the industrial towns and villages, to descend the coal mines and to wander through the remains of the beautiful forest which contributed to the "Hearts of Oak" of Henry VIII's navy, and to get into close touch with the inhabitants, whether they be "Free Miners" or Foresters, and to learn something of their history and the geographical conditions which have played such an important part in the development in what has been, until quite recently, a self-contained industrial unit.

The rocks surrounding the Coalfield form a rim which is highest in the west and north where it is marked by isolated hills, *e.g.* Ruardean Hill, Staunton Meend, and Howle Hill. On the east there is a well-defined escarpment facing east and continuing unbroken for five or six miles. On this eastern brink we have the ridges, Edge Hill and Staple Edge. Travelling south by road from Micheldean to Little Dean, the character of this *edge* is realized as it rises high on the right. So the Forest is practically enclosed by a rim of higher land except on the south, from which direction routes penetrate into the heart of the area, the valley of the Cannop Brook dividing it nearly in half.

STRUCTURE

By referring to the geological map of the Forest area (Fig. 3) the outcrops of the following beds may be seen: In the center the Coal Measures and a layer of coarse sandstone called Drybrook Sandstone, which until recently was thought to be Millstone Grit. Then come beds of Carboniferous Limestone and Old Red Sandstone. These concentric layers are markedly unsymmetrical, there being much unconformity and much variation in the dip of the strata. The Millstone Grit of adjacent coalfields is absent from the Forest of Dean, and the Drybrook Sandstone is now known to represent the upper stratum of the Carboniferous Limestone. It is conformable with the limestone, but unconformable with the overlying coal measures. This Drybrook formation does not extend in an unbroken rim round the coal; in fact, in the southeast the Coal Measures rest directly on the Old Red Sandstone, while in the northeast the Drybrook Sandstone is concealed for five or six miles, and the coal here rests on the Carboniferous Limestone (Fig. 3). On the east side of the coalfield where the Carboniferous layers dip steeply, they present correspondingly narrow outcrops (Figs. 3 and 6). On the western and northern margin where the dip is much less, the gentle undulations make the Carboniferous outcrop very broad (Figs. 3, 4, and 7).

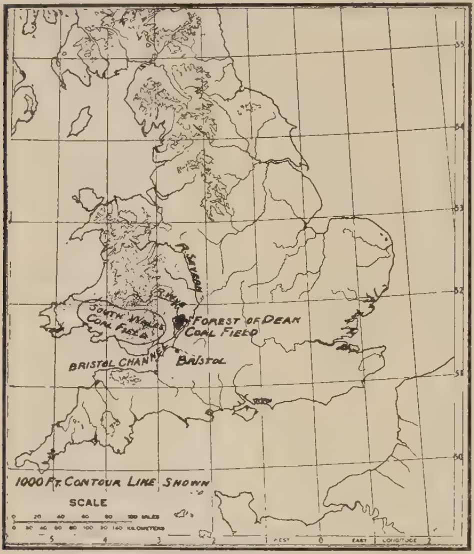
R. SEVERN
R. WYE
SOUTH WALES COAL FIELD
FOREST OF DEAN COAL FIELD
BRISTOL CHANNEL
BRISTOL
1000 FT. CONTOUR LINE SHOWN
SCALE
0 20 40 60 80 100 MILES
0 20 40 60 80 100 120 140 KILOMETERS
5 4 3 2 1 WEST 0 EAST 1 LONGITUDE 2
55
54
53
52
51
50

FIGURE 1.—Map of England and Wales, showing the location of the Forest of Dean.

INDUSTRY

To make a study of the industries of the Forest, Monmouth forms a good starting point; from that town we cross the river Wye by the fine old bridge and, following the Coleford Road, we pass round the north of Kymin Hill and up to Staunton Meend. So far the scenery resembles that of the country west of the Wye in the Red Land of Gwent, because we are still on the Old Red Sandstone plateau. But, from Staunton looking eastward we see the green line of the Forest, while immediately below lies the grimy village of Berry Hill, from which the straggling buildings link up with the chimneys and pit shafts of Coleford. The picturesque agricultural villages are left behind on the Old Red Sandstone; here on the Carboniferous Measures industry is the keynote of the district. Following the road south from Coleford and skirting the southern end of the Forest, we pass coal mining villages, quarries, lime kilns, and abandoned iron mines before reaching Lydney, the one port of the Forest. Here at the docks trucks are drawn up laden with

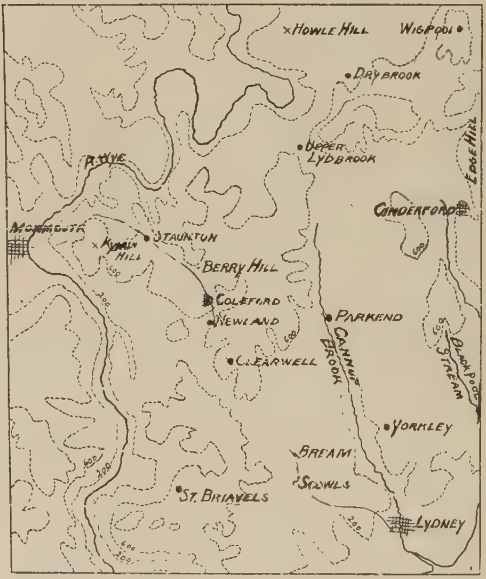
HOWLE HILL
WIGPOOL
DRYBROOK
UPPER LYDBROOK
EDGE HILL
R. WYE
CINDERFORD
MONMOUTH
STAUNTON
KYMIN HILL
BERRY HILL
COLEFORD
NEWLAND
PARKEND
CANNOP BROOK
CLEARWELL
BLACKPOOL STREAM
YORKLEY
BREAM
SCOWLS
ST. BRIAVELS
LYDNEY
600
200

FIGURE 2.—Topographical map of the Forest of Dean area—200 and 600 foot contours are shown.

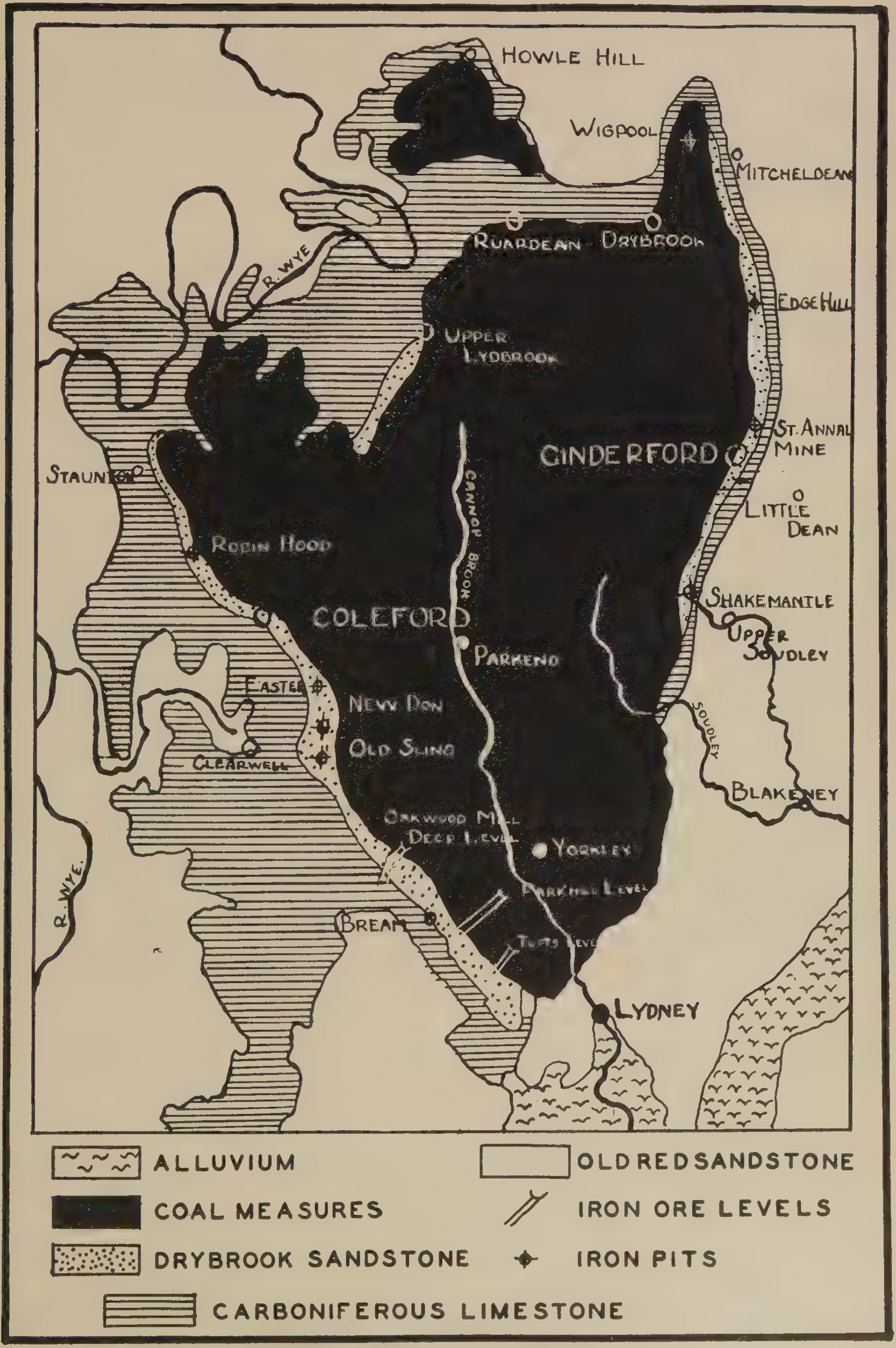
HOWLE HILL
WIGPOOL
MITCHELDEAN
RUARDEAN
DRYBROOK
R. WYE
EDGE HILL
UPPER LYDBROOK
ST. ANNAL MINE
GINDERFORD
STAUNTON
LITTLE DEAN
ROBIN HOOD
CANNOP BROOK
COLEFORD
SHAKEMANTLE
UPPER SOUDLEY
PARKEND
EASTER
NEW DON
OLD SLING
SOUDLEY
CLEARWELL
BLAKENEY
OAKWOOD MILL DEEP LEVEL
YORKLEY
PARKHILL LEVEL
R. WYE
BREAM
TUFTS LEVEL
LYDNEY
ALLUVIUM
OLD RED SANDSTONE
COAL MEASURES
IRON ORE LEVELS
DRYBROOK SANDSTONE
IRON PITS
CARBONIFEROUS LIMESTONE

FIGURE 3.—Geological map of the Forest of Dean.

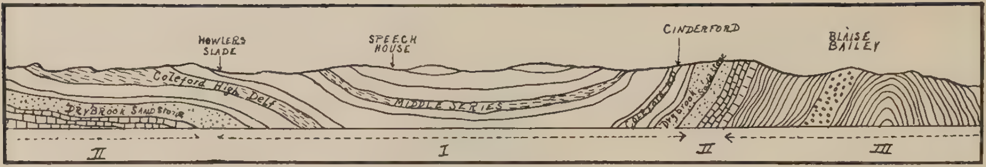

FIGURE 4.—Section across the Forest of Dean, from Howlers Slade to Blaise Bailey (see Fig. 3). (1) Coal Measures; (2) Carboniferous Limestone; (3) Old Red Sandstone and Conglomerates.

coal, forest stone, and timber, the products of industry in this small and isolated unit.

IRON MINING

Mining has been carried on here for centuries. From the Miners' Laws of 1300 we find that the Miners' Court held its meetings at St. Briavels Castle, in the southwest; while a "regard" of the Forest taken in 1282 (Edward I's reign) records that there were 60 forges at work here, which appear to have supplied agricultural implements and horse shoes for the Gloucester fairs. But, the working of iron dates back to the time of the Roman occupation. There is unmistakable evidence that their work was promoted on a large scale. They worked underground and in "day workings," winding passages, open at the surface, called "Scowles" (corruption of Old English word crowll, meaning a cave). One of the best examples of these can be seen near Bream close to the Lydney Road, and is known as the Devil's Chapel (Fig. 8). This is an extremely weird, yet beautiful, region. Vast caverns and pits have been hollowed out, and in the labyrinths worked among the rocks, the roots of the great beeches and yews which clothe the area are exposed resembling ghostly forms in the shaded hollows. Wild flowers and ferns abound in the iron-stained soil and rocks that line the passages and galleries. Some idea of the scope of the Roman workings may be gained from the fact that the smelting of their "cinders" yielded a considerable part of the revenue paid by the Forest to Edward I.

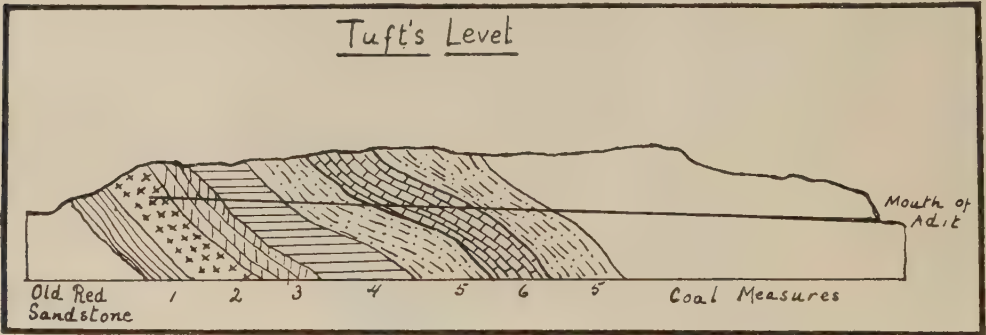

FIGURE 5.—Tuft's Level with entrance in the Cannop Valley. In the Bream-Lydney Area considerable quantities of iron ore have been won from the Drybrook Sandstones. Deep mining is conducted from cross measure adits driven in from the Cannop Valley. (1) Lower Limestone Shales; (2) Lower Dolomite; (3) Crease Limestone; (4) Whitehead Limestone; (5) Drybrook Sandstone; and (6) Dolomite of Drybrook Sandstone.

The iron in the Forest is found only

in two formations: the Drybrook Sandstone and the Carboniferous Limestone. The ore is hæmatite and excellent for the manufacture of steel. It is worked principally in two areas: (1) The northeastern district, and (2) The southwestern district.

1. The Northeastern District extends from Wigpool southwards past Cinderford to the Blackpool valley (Figs. 2 and 3). The iron here has been obtained from the Drybrook Sandstone. The outcrops are now exhausted and the deeper resources have been tapped. Cinderford dominates this district, and most of the iron mined in the east was smelted here until the furnaces were blown out in 1893; since then the bulk has been sent to Dowlais in South Wales.

2. The Southwestern District falls naturally into two divisions: (a) The Coleford area in the north and (b) The Bream and Lydney area in the south.

(a) The Coleford area extends from Staunton in the north to Old Sling Pit in the south. The mining is largely confined to the limestone and is done by means of pits, the outcrop being exhausted. The New Dunn Pit (Pit = shaft) in this area produces half the total Forest production and the highest reserve is located here.

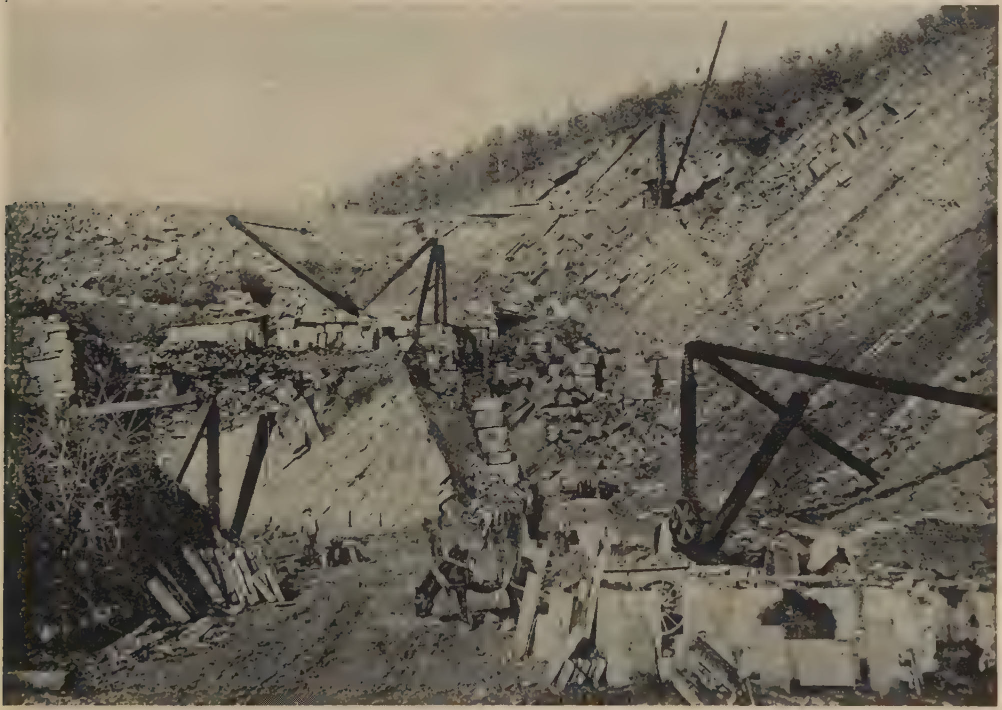

FIGURE 6.—Wilderness Quarry, showing steep dip in the strata on the east side of the Forest.

(b) In the Bream-Lydney area considerable quantities of ore have been won from the Drybrook Sandstone. Deep mining is conducted from cross measure adits driven from the Cannop Valley. (See section of Tuft's level, Fig. 5.)

The beds on the east of the Forest are deepest, for here the dip is

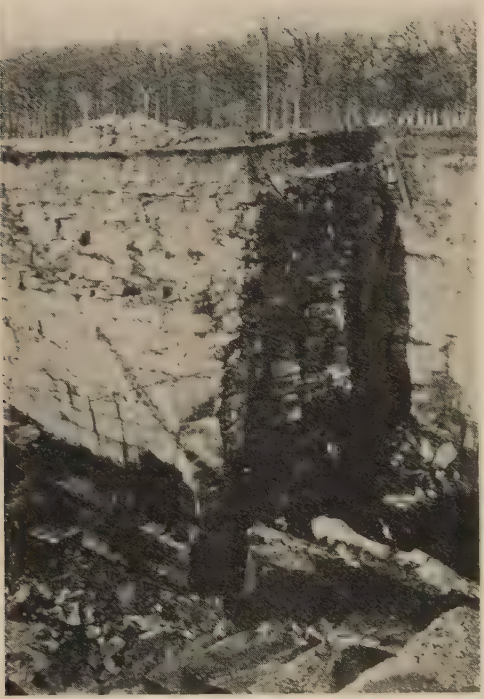

FIGURE 7.—Berry Hill, showing the level strata of the rocks in the west of the Forest.

steepest (Fig. 6). In one case, at Shakemantle Mine, the ore was worked to 900 feet below the outcrop. On the west side, where the dip is gentle, the ore fails at smaller depths; this gives economic importance to the dip of the strata here (Fig. 7). Red ochre, which finds a ready market as a coloring material, is obtained in considerable quantities at High Meadow near Coleford. In fact, Robin Hood Pit is worked principally for ochre, where it is associated with the limestones. It is also worked east of the Forest at St. Annals Pit, north of Cinderford.

For centuries the iron industry has been bound up with the timber of the Forest. The reason is obvious: until the eighteenth century iron was smelted with charcoal, which was easily obtained here. In Henry III's reign, about 1216, the iron works had grown too numerous and were a cause of great waste of timber in the Forest; for in that year "The Constable of St. Briavels is ordered to remove without delay all forges from the Forest of Dean except the King's demesne forges which belong to the Castle of St. Briavels and ought to be sustained with the trunks of old trees wherever they are found in the demesne of the Forest." In Elizabeth's reign the growing demand for a navy added to the value of the timber of the Forest. During the war in Charles I's reign the destruction of the woods was so great that the Forest reverted to the Crown at the request of the Foresters in 1670 after the restoration of Charles II.

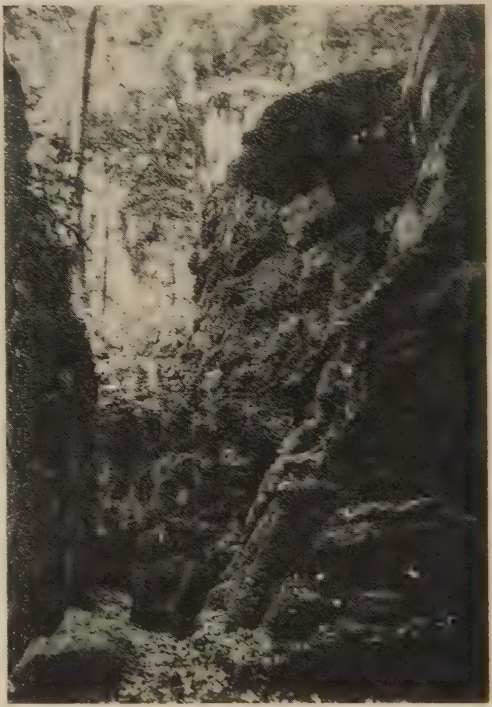

FIGURE 8.—The Devil's Chapel, part of the "Scowles"—old Roman Iron Workings, located outside Bream where the Romans worked the iron at the surface in "day workings," in the Drybrook Sandstone.

TIMBER

Sandstone is the soil most favorable to the oak, and this tree still prevails in the district. When timber was used for ships, the "kneed oaks" were in great demand. One of the finest remaining specimens of these is to be seen outside Newland, on the western edge of the Forest. In the seventeenth century the Forest supplied timber to the shipbuilding yards of Bristol, making that city one of the most important shipbuilding ports of the kingdom. The tendency now is for fir and spruce to replace the oak as the latter takes much longer to reach maturity. The chief markets are Gloucester and Stroud, where the oak is used in the wagon factories. The larches are used for pit props in the Forest collieries. Bark stripping and tanning were carried on until quite recently. There were numerous local tanneries, only one of which remains, at Newnham. Bark used to be sent down the Wye to Chepstow for export, but new methods of tanning have killed these industries.

COAL MINING

Coal mining was also carried on at an early date in this region. In the parish church of Newland on the western edge of the Forest, there is the brass of the heraldic crest of the Baynham family, depicting a miner, dated 1485. Forest records show that this family owned extensive coal reserves here at that date. Today, however, the little coal basin of the Forest of Dean is insignificant from the point of view of production, which has rarely exceeded one million tons per annum (1,239,108 statute tons in 1927). Whether the future will see any advance, it is impossible to say, but from the Coal Commissioner's latest report there is a reserve of only 260 million tons (cp. annual production of England and Wales for 1925: 243 million tons). Of the three series of coal seams, the first is unimportant, because of the inferior quality of the coal, and the thinness of the seams. These veins form the center of the plateau and may gain in importance as electricity is more widely used. The second or Middle Series consists of better quality house coal, but the greatest thickness of the seams is only 3 feet, 9 inches and the coal is exhausted at the outcrop. The third or lowest series of veins is the most

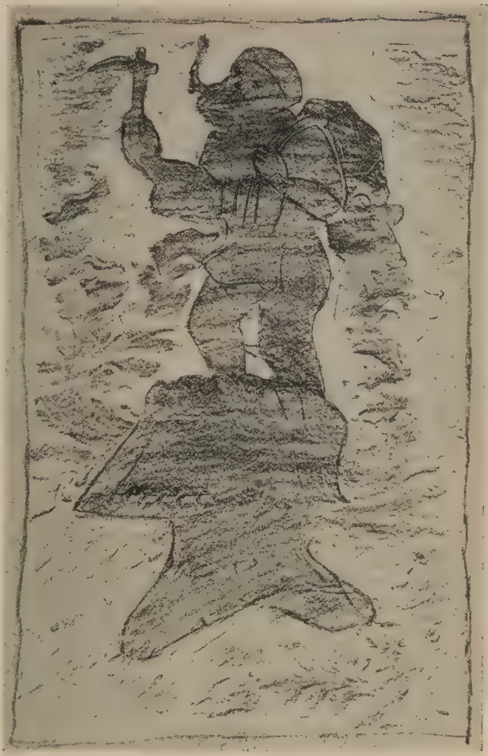

FIGURE 9.—A rubbing of the brass of the heraldic crest of the Baynham family (date 1485) on the floor of Newland Parish Church, showing a miner with a mattock in his hand and a candle in his mouth, illustrating the fact that naked lights were used.

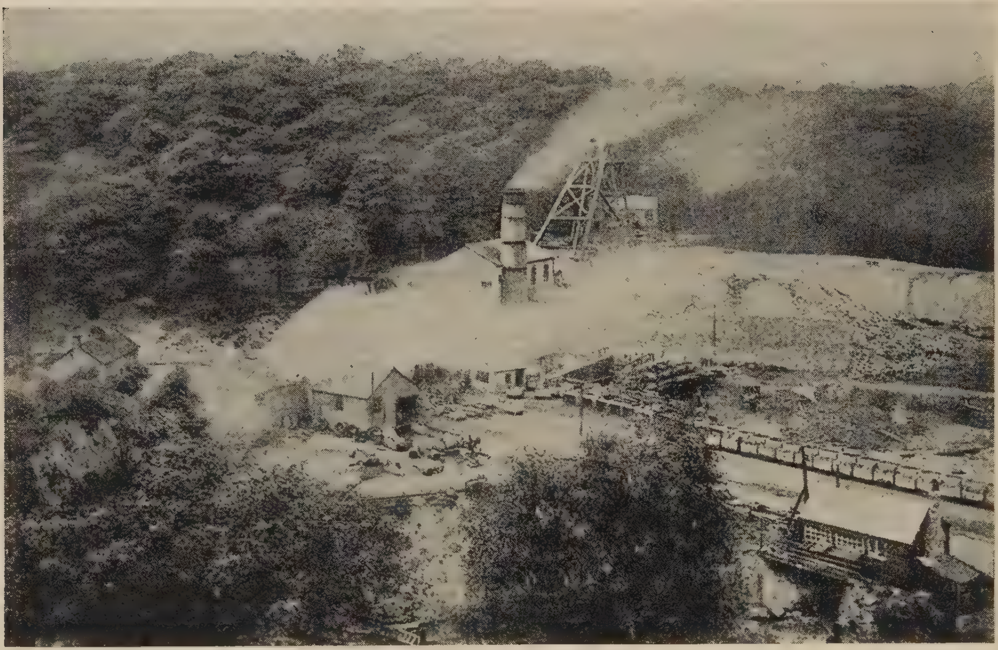

FIGURE 10.—Princess Royal Colliery, situated in the midst of beautiful scenery.

important. The thickest seam in the Forest—the Coleford High Delf—occurs here. This series is worked right round the Forest, and steam coal of excellent quality is obtained. These seams are thicker than those in the first two series, in some parts as much as 15 feet. There are two points of special interest in the mines of the Forest. First, they are free from fire damp. Gwinnell gives as his reason for the escape of the fire damp: "Thick porous sandstones overlie most of the coal seams, through which the carburetted hydrogen escapes instead of accumulating under pressure, as it does where impervious shales form the great mass of the coverings, as they do in many other coalfields." Whether the escape of the fire damp is due to this cause or to the numerous faults which cut up the rock, it is certain that as the fire damp escapes an enormous amount of water is admitted. In consequence of this, the drainage problem is very difficult, and in no other coal field of Great Britain are such powerful pumps required to raise the water. This difficulty has retarded the development of the coalfield, as the Free Miners[1] could not furnish the capital required to develop the deeper parts of the coalfield.

There are three types of coal mines in the Forest: those without power or machinery; the rather better equipped with a certain amount of power, and finally the modern colliery. Only in the northwest of the Forest can primitive workings of the first type still be seen. One example is found between Coleford and Hiller's Slade where the little bricked-in-mouth of the level with its rough wooden gate marks the entrance to the mine. The second type of colliery is to be seen in the Cannop Valley, where a level has been driven into the hillside at the "Norchard." Here, excellent house coal is obtained from the Coleford High Delf seam. The machinery worked by electricity is round the mouth of the level, it pumps the mine and raises the coal to the surface. Here, the visitor can walk down the slippery incline, roofed by shale and wooden beams, to the actual coal beds. The best type of colliery in the Forest is to be seen at the mine of the Cannop Colliery (Fig. 10). The deep coals of the Coleford High Delf are worked here. Modern machinery is used; there are turbine engines, and machinery for cutting and sorting the coal. The depth of this mine is not great; it is 630 feet below the surface and 150 feet below sea level. Most of the coal mined here is marketed in Bristol.

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[1] According to a very ancient custom the mines of the Forest of Dean are leased only to *Free Miners*, that is to those who are born in the Hundred of St. Briavels, and have worked a year and a day in one of the Forest mines. It is supposed by some historians that this right to be a Free Miner was granted in the early part of the fourteenth century, for services rendered to the King in his battles with the Scots. To this day no one but a Free Miner can lease an iron mine, coal mine, or quarry in the Forest of Dean. In actual practice the law has been evaded, for Free Miners are allowed to sell their rights, and many companies have availed themselves of the fact to obtain control of the mines. There are now about 200 Free Miners, some of whom carry on their work by quite primitive methods.

STONE QUARRYING

Although coal is still the most important economic product of the Forest, during the last twenty years another industry has been developing so rapidly that it bids fair to outstrip coal mining; it is the quarrying of the sandstones of the coal measures, which lie between the middle and lower seams of coal. Until the practice of selling their rights became general among the Free Miners, there was little exploitation of the building stone. Now a Bristol company, the United Stone Firms, has acquired all the quarries of the district. The finest grey stone is obtained in the Cannop Valley, in three little "slades" (short steep valleys), leading down from the western plateau—Wimberry Slade being the best known. The beds vary in thickness, 6 feet is the average, though in parts they are 10 or even 15 feet thick. Horse traction is essential owing to the steep gradients and sharp turns in the valleys. The stone is taken to the sawing and dressing works at Parkend and Bixlade. For building the Forest stone is excellent. Examples of its use can be seen in public buildings all over the country. In South Wales it is considered the best stone for resisting the moist smoky atmosphere of the Welsh valleys. Large quantities of the stone were used in the construction of the Severn Tunnel and the Severn Bridge (Fig. 11).

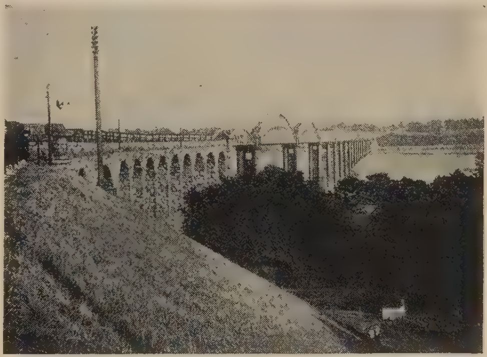

FIGURE 11.—The Severn Bridge, three miles above Lydney. This bridge is built of Forest Sandstone.

DISTRIBUTION OF POPULATION

A comparison of the geological and population maps brings out clearly the connection between the mineral deposits and the concentration of human dwellings. The belt of comparatively dense population extending south from Cinderford to Upper Soudley originated in the working of the now-exhausted iron deposits, and is maintained by the coal measures exploited in more recent times (Fig. 12). Cinderford is placed on the slope of Edgehills away from the low lying brook and at the meeting place of many routes. The main concern of Cinderford is now coal. The tall chimneys of Crump Meadow and Lightmoor Collieries dominate the town. From them the little mineral lines carry the coal into the town, whence it is sent east to the Severn or west to Cannop Valley. The destination of either routes is the port of Lydney in the lower Cannop Valley. Cinderford is an extremely ugly town, but, like all places in the Forest, it has its "common" or "meend" (Welsh myndd-mountain). Commons in the Forest, onto which the villagers turn a motley crowd of sheep, pigs, and fowls are usually on the higher land above the village. Cinderford Meend is not typical in its position, as it lies low, near the stream. It was evidently the scene of early iron workings, as cinder mounds, covered with grass, are scattered over it. It is significant of the barrier character of the eastern hills of the Forest that no railway line crosses the ridge. A motor service has been established between Newnham and Cinderford, but it passes down the Soudley Valley before turning east to the Severn.

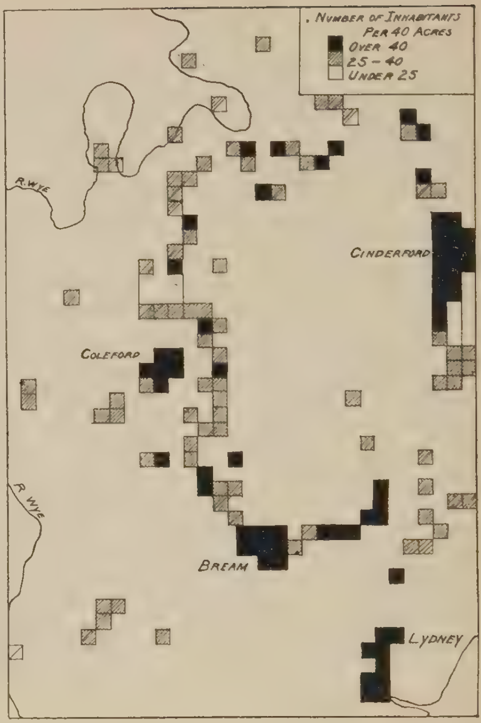

FIGURE 12.—Distribution of population in the Forest of Dean area. By comparing this map with the geological map (Fig. 3), it will be seen that the population is densest where the iron and coal deposits occur close together at Cinderford, Coleford, and Bream. Lydney is an exception, but this town is the port of the Forest on which the important routes converge.

Coleford resembles Cinderford in some respects; its importance is based on mining, originally iron, now coal. Coleford stands on the western threshold of the Forest, but whereas Cinderford is a long *line* of population, Coleford is a *star;* this contrast reflects the difference in structure of the east and west of the Forest. Routes radiate in all directions from Coleford. To the south lies the Milkwall district with Easter Iron Mine, and disused steel works and clay pits. Eastward is a line of coal pits, all disused, while to the west the Scowles show the remains of Roman iron workings but no modern shafts. The ordnance map gives the main railway routes from Coleford: southeastward through Parkend to Lydney, and westward to Monmouth across the Wye. South of Coleford the line of population marked by the villages from Milkwall to Bream shows how closely it is related to the industry of the district. The line crosses the Cannop Valley from Bream and runs northeastward to Yorkley and on to Cinderford. There is a thinning out of the population in the north, which may be explained by the fact that the coal outcrop is almost exhausted here; in addition to this the altitude may account for the sparseness of the population.

Lydney (the island of the Lydd—old name for the Cannop Brook), as its name implies, originated on a hill rising from the marshes at the mouth of the river. It stands where the most important Forest route meets the great roadway from Gloucester to South Wales. A few miles higher up, the Severn Valley narrows and is spanned by a fine bridge (Fig. 11). The Severn and Wye and Severn Bridge Railway passes down the Cannop Valley to Lydney and thence across the bridge to join the Gloucester-Bristol line. Although Lydney is the meeting place of the chief roads and railways of the forest district, there is no direct railway route from Lydney to the Wye Valley; hence, the hinterland of this little port coincides with, and does not reach beyond the area of the Forest. Lydney can never be a large port because the Cannop is only a small stream and the nature of the River Severn at this point makes it impossible for a large port to be maintained on this side of the river. The Cannop has, however, been canalized to a depth of 14 feet, as far as the first bridge. Along the left bank of the Cannop the railway lines pass to Lydney Docks, where the coal trucks are emptied of their contents. It is difficult to obtain detailed information about the distribution of coal by water, but the figures supplied by the Harbour Master of Lydney show that about one-third of the total production of the coalfield is carried by water. Before the war it was taken as far as France and Ireland, but the greater part of the house coal now goes to the coasts of North Devon and Somerset, while the steam coal is sent to Bristol.

In addition to being a port, Lydney has industries of its own. The chief of these is the manufacture of tin plate. The red ochre obtained at High Meadow mines is made into color wash and paint in the town, and there are also cement and brick works based on the alluvial clays and gravels of the river. Lydney is thus the southern projection of the forest land and the gateway through which the Forest District communicates with the outside world, and is linked with the great routes along the Severn and the Bristol Channel.

The main rail routes of the Forest have been indicated, but the chief roads deserve mention, as most of the metalled roads shown on the ordnance map were Roman Ways. This is not surprising when we remember the large scale on which the Romans worked the iron of the Forest. There are remains of Roman pavements at many places, *e.g.* near Lydney—a Roman road passed from Gloucester (Glevum) through Lydney and on to Caerwent. Another passed from Monmouth (Blestium) to Gloucester through Staunton (Stane Town or Town on the Stone Street), where remains of pavements can be seen and vestiges of considerable entrenchments in the vicinity of the church.

After making a study of the economic development of a region as a result of the natural surroundings, the geographer naturally asks, "What of the Future?" The industrial outlook of the Forest is not bright. The only suggested remedy for the dwindling of its industries lies in a colossal undertaking which, so far, has only reached the project stage. The Severn Barrage Scheme, for harnessing the tides of the lower Severn, if carried through, may inaugurate a new period of industrial activity. In the widespread results claimed by the advocates of this scheme, one of the beneficiary districts specially mentioned by the British Board of Trade experts is that of "the Basin of the Severn and the Forest of Dean."

(*Due to lack of space, the Book Reviews are omitted in this issue.*)

ANNOUNCEMENT

THE series on the *Agricultural Regions of Australia*, by Dr. Griffith Taylor, is completed in this issue and Dr. O. E. Baker contributes another instalment of his *Agricultural Regions of North America.*

Dr. Samuel Van Valkenburg of the College of the City of Detroit will begin his series on the *Agricultural Regions of Asia* in the October issue. This will be followed by *Agricultural Regions of Africa* by Homer L. Shantz, President of the University of Arizona, and will complete the finest geographic discussion of the world's agriculture thus far published.

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The April issue of Volume 6 contains the following articles:

Agricultural Regions of Australia, Griffith Taylor, University of Chicago.
Cane-Sugar Production in the British Empire, C. J. Robertson, St. Mary's Training College, Middlesex, England.
Rainfall and Wind Conditions Retarding Tropical Development, Stephen S. Visher, Indiana University.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.
Land Values in the Blue Grass and Nashville Basins, Raymond E. Murphy, University of Wisconsin.

January includes:

Agricultural Regions of South America, Clarence F. Jones, Clark University.
The Potato Industry in Nebraska, Esther S. Anderson, University of Nebraska.
Agriculture in the Dry Region of the U.S.S.R., N. M. Tulaikov, Agricultural Experiment Station, Saratov.
The German Sugar Beet Industry, E. Muriel Poggi, University of Illinois.
Divisions of the Pine Forest Belt of East Texas, William T. Chambers, Stephen F. Austin State Teachers College.

The October issue of Volume 5 contains the following articles:

Geography's Part in the Plant Cost of Iron and Steel Production at Pittsburgh, Chicago, and Birmingham, Langdon White Randolph-Macon Woman's College.
Readjustments in Post-War Cotton Culture, Earl C. Case, University of Cincinnati.
Tung Oil: Florida's Infant Industry, M. Ogden Phillips, Formerly, University of Florida.
The Farm Problem, Robert Stewart, University of Nevada.
Forest Regeneration in Porto Rico, William D. Durland, Formerly, University of Porto Rico.
The Topographic Map of the United States, Guy Elliott Mitchell, U. S. Geological Survey.
Agricultural Regions of South America, Clarence F. Jones, Clark University.

July includes:

Canada's Advance to Hudson Bay, Harold S. Patton, University of Cincinnati.
Economic Conditions in St. Vincent, B. W. I., G. Wright, Imperial College of Tropical Agriculture, Trinidad.
Economic Geography of the Hawaiian Islands, Otis W. Freeman, State Normal School, Cheney, Washington.
Agricultural Regions of South America, Clarence F. Jones, Clark University.
Iron and Steel Industry of the Cleveland District, John B. Appleton, University of Illinois.

April includes:

Agricultural Regions of South America, Clarence F. Jones, Clark University.
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The Sugar Industry of the British West Indies and British Guiana with Special Reference to Trinidad, C. Y. Shephard, Imperial College of Tropical Agriculture.
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The Grape Industry of Spain and Portugal, W. O. Blanchard, University of Illinois, and Elizabeth R. Blanchard.
The Philippine Lumber Industry, Luis J. Borja.

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Industrial China, H. F. James, Wharton School of Finance and Commerce.
Land Resource Inventory of Michigan, Carleton P. Barnes, Michigan Land Economic Survey.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.
Scranton's Industrial Integrity, Clifford M. Zierer, University of California at Los Angeles.
A Critical Situation in Two One-Crop Wheat Farming Districts in California, John W. Coulter, University of Hawaii.

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F. Bogardus, *Geographer,* Wharton School of Finance and Commerce

THE SUGAR INDUSTRY OF MAURITIUS
Robertson, *Geographer,* Istituto Internazionale d'Agricoltura, Rome, Italy

AGRICULTURE AND COMMERCE OF UGANDA
Earl C. Case, *Geographer,* University of Cincinnati

LOWER RIO GRANDE VALLEY OF TEXAS
liam T. Chambers, *Geographer,* Stephen F. Austin State Teachers College

LAND UTILIZATION IN THE ST. FRANCIS BASIN
Sam T. Bratton, *Geographer,* University of Missouri

THE LIME INDUSTRY AT ROCKLAND, MAINE
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F. Howe, *Geographer,* State Normal School, New Britain, Connecticut

MOUNTAIN TOPS AND LOWLANDS OF COLOMBIA
Albert C. Smith, *Assistant Curator,* New York Botanical Gardens

GLACIAL TOPOGRAPHY AND AGRICULTURE IN CENTRAL MASSACHUSETTS
Berton R. Millington, *Geographer,* Brown University

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Dr. Robertson, who was formerly lecturer in geography at St. Mary's Training College, Middlesex, England, is now connected with the International Institute of Agriculture at Rome, Italy. He graduated in natural sciences and in economics from the University of Edinburgh, and obtained his Ph.D. degree from the University of London. He was also formerly a lecturer on the sugar trade at the City of London College.

Dr. Case, now professor of geography at the University of Cincinnati, spent the summers of 1922–1924 with the Tennessee State Geological Survey. In 1925 he received his Ph.D. degree at the University of Chicago, and was connected with the Resource Survey of the University of Cincinnati from 1925–1927. He has written several papers including "Relationship of Industry to Environment in the Valley of Eastern Tennessee" for the Tennessee State Geological Department at Nashville, and "Forests and Forest Industries of Marine Regions" which appeared in the Bulletin of the Geographic Society of Philadelphia, July, 1929, issue, pages 213–234. An article entitled "The Pastoral and Agricultural Industries of Kenya Colony and Protectorate" by the author appeared in the July, 1930, issue of ECONOMIC GEOGRAPHY.

Dr. Chambers is associate professor of geography at the Stephen F. Austin State Teachers College, Nacogdoches, Texas. He is the author of "Geographic Divisions of the Pine Forest Belt of East Texas," which appeared in the January, 1930, number of ECONOMIC GEOGRAPHY, and "Life in a Cotton Farming Community," which appeared in the April, 1930, issue of the *Journal of Geography.*

Dr. Bratton is professor of geography at the University of Missouri and director of curriculum study in geography in coöperation with the Missouri State Department of Education. Recent contributions in educational work are two courses of study, *Junior High School Geography* and *Senior High School Geography*, and a *Source Book for Junior High School Geography.* In addition, Dr. Bratton has published a *Work Book in Geography* for elementary schools, and a *Geographic Reader of Missouri.* He is also the author of a number of articles dealing with phases of economic geography.

Mr. Finch, formerly of Montana, is now at the State Normal School, Danbury, Connecticut. He is the author of the Montana section of the Frye-Atwood Geography and of New England Geography for the Dodge-Lackey Series.

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Mr. Smith, who is at present assistant curator of the New York Botanical Gardens, received his A.B. degree from Columbia University in 1926. He has made many trips to Colombia, Peru, and Brazil, collecting data and material. He has written a number of taxonomic publications, which appeared in various botanical journals.

Mr. Millington, who contributes an article entitled "Glacial Topography and Agriculture in Stow, Massachusetts," received his Master's degree from Brown University in 1930. He did his graduate work in the field of geography and physiography, writing his thesis on the Pleistocene deposits of Rhode Island. While working during the summer of 1929 in the neighboring town of Stow, an excellent opportunity arose to study the economic reaction to physiographic influences within the region. The basic material of the resultant report was rewritten to form the present article.

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ECONOMIC GEOGRAPHY

VOL. 6 OCTOBER, 1930 No. 4

THE GREAT BASIN

J. F. Bogardus
Geographer, Wharton School of Finance and Commerce

THE Great Basin includes an area of about 200,000 square miles lying in the Basin and Range Division between the Rocky Mountains and the Sierra Nevadas. Its shape is nearly that of an isosceles triangle; its northern side lies along the divide of the drainage basin of the Columbia River, its eastern side along the divide of the drainage basin of the Colorado River, and its western side in the central part of the Sierra Nevada crest. Included within its boundaries are almost the whole of Nevada, the western half of Utah, the southwestern corner of Wyoming, the southeastern corner of Idaho, a large area in southeastern Oregon, and much of southern California together with a strip running along the eastern border of that state.

It is one of the most interesting and picturesque sections of the United States and might well be termed, "The Land of Contrasts." The brilliant green of its irrigated valleys is in striking contrast to the brown and grey waste of its deserts. It contains some of the least valuable land in our country and yet hidden within the bare fastnesses of its mountains are deposits of gold, silver, copper, and other rare and valuable minerals. It has an eerie beauty which allures and fascinates one to the extent that it is not easily forgotten. Hundreds have perished of thirst in its deserts and yet here are found the prehistoric homes of a vanished race, the cliff dwellers, who are supposed to have sought refuge within its borders. To the protection of its isolated oases fled the Mormons seeking a land where they might live their own lives free from persecution. To one who travels through any of its desert regions it becomes a never-to-be-forgotten land. To look out across its vast stretches of sand, dotted with cactus and sagebrush, to watch the heat waves vibrate under the rays of a noonday sun, and to see the little dust devils whirled hither and yon near the base of its brown, cardboard mountains, is a sight which cannot be found elsewhere in the United States.

Within its borders it contains the remnants of our last frontier. In certain sections is to be found almost the last of the open range over which the cattle barons still exercise something of their old domination. Many of its remote regions have never been fully charted or explored. Its barren mountains still conceal deposits of valuable metals which from time to time are unearthed by the prospector. The Indians living within its bound-

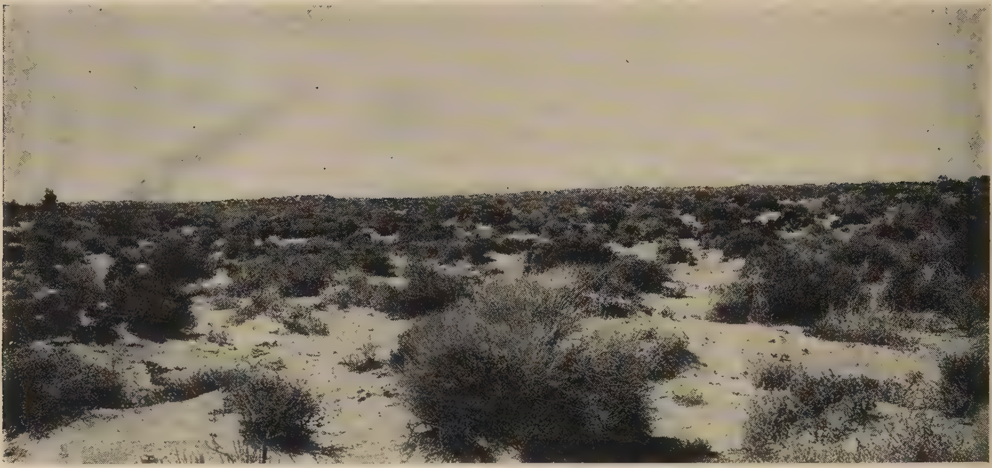

FIGURE 1.—Typical desert scene in Nevada. (Courtesy of Bureau of Reclamation, U. S. Dept. of Int.)

aries still carry their dead into its fastnesses for burial in unknown graves and by weird ceremonies attempt to propitiate the evil spirits which lurk in its mountains. But even this frontier is passing. Where water makes irrigation possible the open range is being broken up into small farms. Its remote parts are being charted, its mineral resources are being rapidly exploited, and even cities have sprung up in its more accessible regions. But its vast desert areas remain, and must always remain, largely untouched to charm and allure the traveler who ventures within the range of their spell.

PHYSIOGRAPHY

Water is the dominating factor in the life of the Great Basin. The existence of it means irrigation, a relatively dense population, and prosperous communities, while its absence means uninhabited desert or at the most extensive grazing supporting a very sparse population. Unfortunately water is extremely scarce in the Great Basin. The High Sierras shut off the rain-bearing winds from the Pacific and the Rocky Mountains to the east prevent the cylconic storms from bringing any moisture from that direction. Thus, the rainfall is very slight varying throughout most of the area from five to ten inches per year. For example, Reno, Nevada, located near the western side of the Basin, has an annual average precipitation of 8.7 inches. Most of the precipitation which does occur takes place on the slopes of the mountains bordering the Basin or on the highest of the Basin Ranges. Much of this comes in the form of snow and it is among these snowfields that most of the Basin streams have their origin.

This lack of rainfall has given to the Great Basin certain arid characteristics which are almost unique in the United States. Interior basins, streams which disappear in piedmont slopes and salt lakes characterize the region. It is entirely an area of interior drainage, that is, none of the water within its borders reaches the ocean by surface drainage. The majority of the water brought down from the mountains by the streams is absorbed or evaporated and such water as remains collects on the basin floors in the form of salt lakes.

Thus, the Great Basin is really a collection of interior drainage basins in which arid characteristics are most marked.

In a region of this type erosion is pronounced and as the streams have no outlet to the ocean, the material which they carry is deposited on the valley floors often to a depth of from one to three thousand feet. This process if continued will ultimately result in the formation of a plain, and although in most sections the plain-forming process is still in its early stages, most of the valley floors are broad and flat.

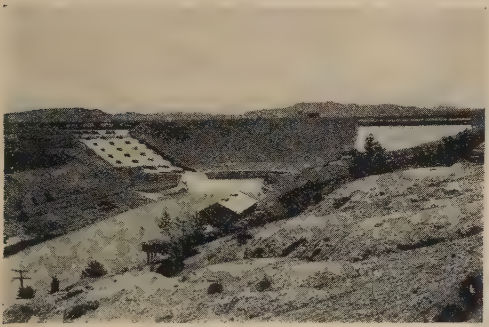
FIGURE 2.—Lahonton Dam, Newlands Irrigation Project, Nevada. (Courtesy of Bureau of Reclamation, U. S. Dept. of Int.)

The streams which have their rise in the bordering mountains and in the Basin Ranges, having no outlet to the sea, spread out over these valley bottoms forming shallow lakes. As the water of these lakes is evaporated a dense brine of common salt, sodium sulphate, and alkali remains. Great Salt Lake, for example, is said to contain some 400,000,000 tons of common salt and the solution is so dense that one may float in it without sinking. Many other lakes of the Great Basin are of this same type, these include Humbolt Lake, Carson Lake, and the lakes of central Oregon. Some of the Basin lakes are, however, of clear water, among these being Utah Lake, Bear Lake, and Lake Tahoe. The latter, located in the Sierras, is one of the most beautiful lakes in the United States. The sweetness or pureness of the lakes is determined by the existence or non-existence of an uninterrupted outlet; those lakes having an uninterrupted outlet contain fresh and sweet water, while those having an interrupted outlet or no outlet at all contain salt and other materials in varying amounts.

An interesting feature of most of the Basin Lakes is their constantly changing size and temporary character. The flatness of the valley floors causes them to be very large but very shallow. In many cases water exists in these lakes only during periods of high water and when this period has passed they evaporate, rapidly exposing broad expanses of mud flats known as "Playas." For instance, "Black Rock Desert in northwestern Nevada becomes in the spring rains 450 square miles of lake only a few inches in depth. But soon it is shining white with the crystals of alkali that remain after the water has dried up, leaving a typical 'alkali flat.'"[1] Even the lakes that are permanent vary greatly in size. The Great Salt Lake has expanded and contracted with changes in rainfall. "Since definite knowledge of the lake began, in 1850, there have been five periods of increase and four of decrease. The summer levels of 1868 and 1877 were more than 10 feet above the summer level of 1850, and those of 1903 and 1905 were 4 feet below those of 1850. The level of 1914 was 6 feet above that of 1905."[2] During the Glacial Epoch the cold retarded evaporation and the water level rose until two lakes of tremendous size occupied the Great Basin. To the eastern one of these lakes, geologists have given the name of Lake Bonneville, and to the western one, Lake Lahontan. When Lake Bonneville attained its maximum size, it was comparable in depth and extent with Lake Michigan and the water level rose more than 1,000 feet above the present level of Great Salt Lake. "About the borders of Great Salt Lake may be seen shore features associated with the ancient lake levels and still in almost perfect state of preservation. Upon the surrounding slopes and up to elevations of 1,500 feet above the surface of Great Salt Lake are well-defined deltas, bars, beaches, spits, capes, cliffed promontories, and bottom deposits, all formed by or associated with ancient lakes whose waters once stood at these high levels."[3] The waters rose so high that they flowed out through Red Rock Pass into the Portneuf River, a tributary of the Snake River, which in turn is the chief tributary of the Columbia. Thus for a time the Bonneville Basin became part of the drainage system of the Pacific Ocean. Lake Lahontan also attained large size but never rose sufficiently high to have an outlet. Thus, in the past the water level of the Basin lakes has risen and fallen in response to changes in precipitation and evaporation. Recently, an additional factor has also influenced the water level; this factor is the diversion of water from the streams for the purpose of irrigation. These three factors today determine the size of the Basin lakes and a change in any or all of them would exert a profound change on the amount of water they contained and consequently upon the life of the region.

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[1] Smith, J. R., "North America," p. 510.
[2] U. S. Geological Survey, Bulletin 612, p. 96.

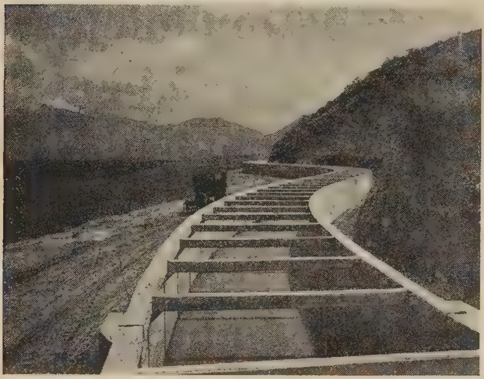
FIGURE 3.—Curve on the High Line Canal, Strawberry Valley Irrigation Project, Utah. (Courtesy of Bureau of Reclamation, U. S. Dept. of Int.)

As has been previously pointed out, the rivers of the Great Basin receive most of their water from the melting snows of the mountains. As a consequence the stream flow is variable, the maximum occurring during the late spring and early summer months when the snow is melting, with a decrease during the summer months and a minimum during the winter. Many of the streams entirely disappear during the dry period. In a few cases lakes serve as natural storage reservoirs and the streams which flow from them have a fairly regular run-off. This is true of the Carson and the Truckee and a few other streams descending from the Sierra Nevadas and the Wasatch Mountains. However, as only a small portion of this area has been glaciated, lakes are scarce and most of the streams, especially those rising in the Basin Ranges, are variable as to length and discharge.

Other features of the Great Basin which are of interest are the roughly parallel mountain ranges which cross it from north to south. Geologists tell us that these ranges are the results of faulting of great blocks of the earth's crust. These blocks have been turned up on edge, and as a consequence, the mountains have a sharp crest with steep slopes on one side and gentle slopes on the other. These ranges appear to be oldest in the south where erosion has caused much of their original outline to disappear. In the north they are of most recent origin and their original form has been but slightly changed. There are also many evidences that faulting still continues in these Basin Ranges. In a few cases these mountains are high enough to catch sufficient moisture to support tree and grass growth, and where this is the case, they are frequently used as summer pastures.

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[3] Bowman, Isaiah, "Forest Physiography," p. 214.

The soils of the Great Basin are made up of a great variety of rock and consist of wash from mountain slopes, shore deposits associated with ancient lakes, recent stream valley sediments and river delta deposits. Part of these soils are rendered useless by the accumulation of alkali or seepage waters, but where this is not the case and where water is available for irrigation they are of great agricultural value. From the agricultural point of view the best soils are those along the valley bottoms and stream sediments in the vicinity of river flood plains. These occur in low or slightly elevated valleys which have a smooth or gently rolling surface.

The physiography of the Great Basin is thus of great interest to those familiar with geology or physical geography. Its interior drainage with its salt lakes of varying size, its block-faulted mountains which contain evidences of recent faulting, and its variable rivers frequently disappearing into piedmont slopes tend to make it a physiographer's paradise and a veritable treasure-mine to all who are interested in our physical environment.

RESOURCES AND INDUSTRIES

As Nevada and Utah are the states having the greatest portions of their areas lying within the Great Basin, and as within their boundaries are to be found conditions typical of all parts of the Basin, the present discussion covering resources and industries will be limited to those two states.

NEVADA—SIZE AND GENERAL CHARACTERISTICS

Nevada is the sixth state in the United States in size having a total area of 110,690 square miles. Almost its entire area lies within the boundaries of the Great Basin and it is probably the most typical of the Basin states. The barrier of the Sierra Nevadas to the west has so reduced the rainfall that by far the largest part of the state is arid and desert land. It is the great dry plains of Nevada, dotted here and there with clumps of bunch grass, that form almost the last of the open range. Hidden within its brown-faulted mountains, Nevada holds large deposits of gold, silver, copper, and other valuable ores. These two industries, namely stock-raising and mining, are dependent upon natural conditions which are found widely throughout the area of the Great Basin. Her people also seem to have absorbed something of the spirit of the desert and to combine within themselves certain desert characteristics which, while picturesque and fascinating, have not always worked out to the best interests of the state.

POPULATION

As to the population, Nevada is the most empty state in the United States. Although ranking sixth in size, it has consistently held the lowest position with regard to the number of inhabitants. According to the Federal Census of 1920 Nevada contains about 77,000 people and this marks a decline of over 5 per cent since 1910. The reasons for this decline are to be found in the character of the population and in the mining and agricultural development of the state.

The population is largely made up of whites with a few Indians, negroes, Japanese, and Chinese. The white element contains a large number of shifting, single laborers. They come to work for a time in the mines or on the ranches and then pass to other fields, or they may come to build homes, but discouraged by the scarcity of water or the antagonism of the cattlemen, they move to a more hospitable area. The seriousness of this situation is illustrated by the fact that only 32 per cent of the population is born within the state itself. The reasons for this shifting population may be found in various elements of her life, such as the efforts of the ranchers to prevent the break-up of the range and the fluctuating character of the mining and ranching industries. But whatever the cause, the seriousness of the situation cannot be denied for it deprives the state of stable, skilled labor and brings to it a class of men who do not, as a rule, make the most desirable citizens.

The school system has in the past been backward, but at present this condition is being improved and it is hoped that within the near future the state will rank well in educational facilities.

FIGURE 4.—Wheat ready for harvest, Newlands Irrigation Project, Nevada. (Courtesy of Bureau of Reclamation, U. S. Dept. of Int.)

Nevada has only one city of any importance; namely, Reno, which in 1920 had a population of 12,000. The small importance of the towns and cities may be seen from the fact that only 19 per cent of the population is urban.

Nevada thus has a population much smaller than that of Camden, New Jersey, and one which fluctuates with the ups and downs of the mining and ranching industries. A considderable portion of this consists of shifting labor which takes little, if any, interest in the development of the state. Here then is one of the chief problems which faces the state, and unless these conditions can be remedied, there seems to be little hope of any great progress in the future.

AGRICULTURE

General agriculture is not of great importance in Nevada. In 1925 there were 4,090,586 acres in farms or 5.8 per cent of the land of the state. This marks an increase of 1,733,423 acres over the amount in farms in 1920. However, only about 13 per cent of this farm area is classified as crop land, the remainder being mostly pasture. The arid character of the state has made it necessary to keep the farms large and the average acreage per farm in 1925 was a little over 1,053 acres, and the average value of all farm property per farm in the same year was $25,260. The principal crops according to acreage in 1924 were hay and forage, wheat, barley, white potatoes, oats, and cantaloupes, in the order named. The acreage of all of these crops with the exception of barley decreased between 1919 and 1924. Some fruit, including apples, peaches, pears, plums, and grapes, is also raised. It is thus evident that general agriculture is not of great importance in Nevada, and although there has been an increase in farm lands, the majority of that increase is in pasture land and not in crop land.

Because of the dryness of the climate 94.4 per cent of the improved land in Nevada is irrigated. The acreage irrigated in 1920 was 561,447, which marked a decrease of 20 per cent in the irrigated acreage since 1910. The principal streams used for irrigation are the Humbolt River, which rises in the northeastern part of the state and flows in a southwesterly direction and the Truckee, Carson, and Walker Rivers which rise in the Sierra Nevadas in California and flow in an easterly direction. The largest irrigation project in the state is the Newlands Project of the United States Reclamation Service. This uses the waters of the Truckee and Carson Rivers to irrigate the plains around Carson City where it is hoped that in the future some 230,000 acres will be brought under irrigation. Although water is available for irrigating only a small fraction of the state, yet the present irrigated acreage can be considerably expanded. Such expansion provides the only real possibility for the extension of cultivated agriculture, and will aid the state by attracting to it a home-owning, industrious type of citizen who will take a real interest in state affairs.

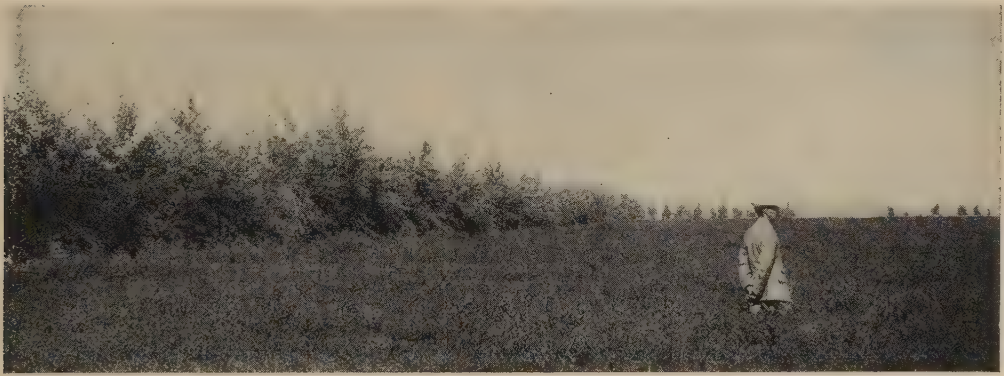

FIGURE 5.—First-class stand of alfalfa ready for cutting, Newlands Irrigation Project, Nevada. (Courtesy of Bureau of Reclamation, U. S. Dept. of Int.)

LIVESTOCK

The raising of livestock is a very important industry in the state, the total value of all livestock being $26,373,528 in 1925. Cattle and sheep raising are the most important, but in addition to these horses, swine, and chickens are raised in some quantities.

There were in 1925 some 1,183,500 sheep in Nevada and these produced approximately 8,000,000 pounds of wool. This marks a considerable increase both in the number of sheep and the amount of wool over 1910 and 1920. There were in the same year some 419,000 cattle of which 17,380 were dairy cows. This marks a slight decline in the number of cattle since 1910, but shows a decided increase in the number of dairy cows. This has been accompanied by an important increase in the production of dairy products. Cattle and sheep raising are carried on extensively on the open range. In summer many of them are taken up into the mountain pastures and in the winter they are brought down into the valleys where some forage crops are frequently produced to tide them over the dry season. Cattle raising is at once a strength and a weakness to the state. It is today Nevada's second most important industry, but it is an industry which in part has retarded the growth of more general agriculture and has aided in maintaining the large shifting population of the state.

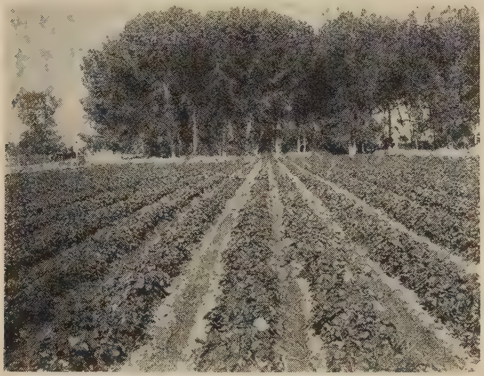

FIGURE 6.—Strawberry patch near Fallon, Newlands Irrigation Project, Nevada. (Courtesy of Bureau of Reclamation, U. S. Dept. of Int.)

Much of the state will never be suitable for anything but stock raising and large areas are not even suitable for that, but in many sections the soil is very fertile and, where irrigation is possible, will grow large crops. If these sites can be used for irrigation, a class of home builders will come in who will not only add to the wealth of the state by their products but will tend to stabilize its population and give to Nevada an increasing group of citizens who will be vitally interested in her welfare. Present indications point to the fact that this change has begun and it is hoped that it will continue steadily.[4]

MINING

It was the search for mineral wealth which led to the first white settlements in Nevada. Since 1859 when the famous Comstock Lode, one of the world's most notable silver mines, was discovered, the mining industry has expanded and contracted with the discovery of new deposits

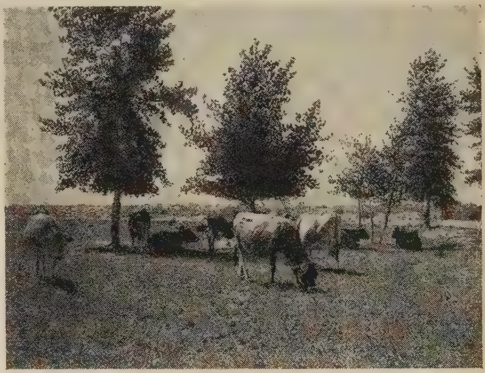

FIGURE 7.—Registered Jerseys, Newlands Irrigation Project, Nevada. Note the desert in the distance. (Courtesy of Bureau of Reclamation, U. S. Dept. of Int.)

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[4] Statistics concerning agriculture were taken from the U. S. Census of Agriculture, 1925, Nevada, Statistics by Counties.

and the working-out of old ones. These fluctuations have caused corresponding variations in the population and the prosperity of the state. Similar fluctuations have been caused by changes in world prices of the various metals mined. For example, the total value of the gold, silver, lead, and zinc produced rose to $54,424,580 in 1917, fell to $12,137,536 in 1921, rose to $25,040,349 in 1923, and in 1926 was $24,549,991. Within recent years gold and silver have been decreasing in importance while copper, lead, and zinc have been becoming more important. Copper especially has increased in importance within recent years. Normally, Nevada holds second rank among the states in the value of the products of its gold and silver lode mines, sixth place in the production of copper and eleventh place in the production of lead and zinc.

Today deserted mining towns mark the sites of once thriving centers, but as old communities die new ones spring up, and it seems likely that important new deposits of minerals will be found in the future and that mining will remain one of the most important industries in Nevada.

MANUFACTURING

Nevada is comparatively unimportant in manufacturing, ranking forty-eighth among the states in this respect. Her most important industries are car and construction shops, slaughtering and meat packing, and printing and publishing. Metallurgical industries are also of increasing importance. These include smelting and milling plants for the recovery of gold and silver by amalgamation and cyanidation. However, the development of the state in manufacturing will never be great as it lacks such important factors as power, labor, and markets. Such manufacturing as does develop will probably be concerned with satisfying certain local needs and in preparing the products of the mines and farms for transportation to other centers.

SUMMARY

Nevada has not increased rapidly in importance and has actually shown a decline in certain lines. Although economically it will never take an important place among the states of the United States, yet it has possibilities of improving its present status. If its water is made available for irrigation and settlement encouraged, the prosperity of the state will be advanced from both a human and a material point of view. The development of Federal Projects on the Colorado River seem likely to considerably increase the possibilities of irrigation within the state. Its future undoubtedly lies in irrigating such land as is possible, in continuing the raising of livestock, and in the continued development and expansion of its mining industry. However, the majority of the land must ever remain a desert, and although picturesque it will add little if anything to the wealth of the state.

UTAH—SIZE AND GENERAL CHARACTERISTICS

The development of Utah has been in marked contrast to that of Nevada. The state has progressed steadily making excellent use of its resources and as a consequence we find here a thriving, growing community which is making its influence felt over an increasingly wide area. The chief causes for the differences in the development of these two states lie in the better natural resources and different type of population to be found in Utah. This state illustrates the fact that sections of the Great Basin contain factors which, if properly utilized, can support a prosperous community.

Utah ranks tenth among the states in size, having a total area of some 85,000 square miles. The western half of the state lies within the Great Basin. To illustrate this in another way, seventeen of its twenty-eight counties lie wholly or in large part within the Basin section.

The state contains many interesting features. One of the most important of these is the Great Salt Lake which is the largest inland body of salt water in the United States and the largest body of water within the Great Basin. On the shore of this lake is Salt Lake City, the capital of the state and the largest city within the state or within the Basin. Southwest of this lies the wide expanse of the Great Salt Desert which shares with the Mohave Desert the distinction of being the largest and most interesting desert region in the Basin and in the United States.

The state is similar to Nevada in that the entire region is arid with the exception of the higher elevations, but it differs from Nevada in that it contains much larger areas of land suitable for agriculture and has larger water supplies for irrigation.

POPULATION

Utah was settled by the Mormons who still comprise the most important population element within the state. They are hard working and industrious, and with them the community spirit has been developed to a marked degree. Their characteristics have had a dominating influence upon the development of the state. Their early leaders caused the attention of these people to be directed towards agriculture so that they built up stable communities before their mineral resources were exploited. According to the Census of 1920 Utah had a population of 450,000, and in this respect it held twentieth rank among the states.

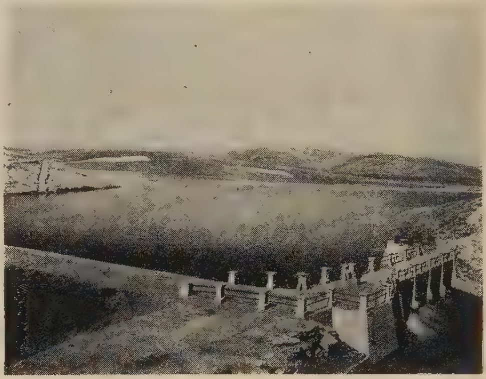

FIGURE 8.—Strawberry Dam and reservoir, Strawberry Valley Irrigation Project, Utah. (Courtesy of Bureau of Reclamation, U. S. Dept. of Int.)

Over 98 per cent of the population is white and by far the largest part of it is native American stock. Such foreign elements as are found come chiefly from central and northern Europe.

The state contrasts with Nevada in the fact that its population is quite stable, 69.9 per cent of its people being born within the state. It is thus not faced with the problem of a large supply of shifting laborers.

The school system and educational program of the state are excellent. In this connection it is interesting to note that 88 per cent of the state's revenues are spent for educational purposes. The result is shown in the unusually low percentage of illiterates, this being 2.5 per cent in 1920.

About half of the population of the state is urban, and there are three cities each containing 10,000 people or over. These cities are Salt Lake City with a population of 118,110, Ogden with a population of 33,000, and Provo with a population of about 10,000. These statistics of population are from the Federal Census of 1920. All of these cities are to be found in the portion of the state lying within the Great Basin.

The character of the population is an important factor in explaining the excellent growth and development of the state. The continuation of this growth is indicated by the fact that the population increased 20.4 per cent from 1910 to 1920 and that this increase was composed largely of those who came to Utah to make the state their home.

AGRICULTURE

In agricultural development Utah also presents a marked contrast to Nevada. Although the state has on the western slopes of the Wasatch Mountains better agricultural territory than is to be found in Nevada and although these mountains furnish an excellent supply of water for irrigation, yet it has done more to utilize its resources than has its neighbor. As in Nevada, stock raising is here carried on in sections too dry for the production of crops.

About 10 per cent of the land of the state is in farms, and about 29 per cent of this amount is classified as crop land, the remainder being largely pasture. The largest part of this farm land lies within the Great Basin. Farming is on the increase, as may be seen by the fact that farm acreage has increased from 3,397,699 acres in 1910 to 5,000,724 in 1925. As diversified farming is extensively practiced, the farms are of normal size averaging 192.4 acres in 1925, and over 89 per cent of them are operated by owners.

The value of all the crops in 1927 amounted to $39,000,000, and the value of those produced in the Great Basin was about $32,000,000. This valuation marks a considerable increase over 1910 but marks a decrease of $19,000,000 from the value of the crops produced in 1919. By far the most valuable crops of the state are hay and forage. The value of these amounts to about 37 per cent of the value of all crops and they also occupy the largest acreage. Next in importance comes wheat, and this is followed by sugar beets in which Utah holds a high place. Oats and corn are also of considerable importance. Utah produces large amounts of fruit and vegetable products, among the most important of which are apples, cherries, grapes, peaches, potatoes, peas, tomatoes, and onions. Potatoes alone represented a value of $2,228,000 in 1927. Fruits are to be found on the foothills and slopes of the Wasatch Mountains and are of increasing importance.

The soils of Utah are rich and well mixed, often extending to a depth of 40 feet. Where sufficient moisture is available or where irrigation is possible these soils produce large and valuable crops. Utah ranks among the leading states in the production per acre of such crops as sugar beets, spring wheat, potatoes, barley, and alfalfa. As the majority of these crops are grown within the Great Basin, this illustrates the fertility of the Basin soils if they are well cultivated and irrigated.

A few of the grain crops, especially winter wheat, are grown by dry farming methods, but because of the dryness of the climate 80 per cent of the improved land of the state is irrigated. In 1919 the irrigated acreage was 1,371,000 acres, and it has increased slowly but steadily since that time. With the extension of irrigation projects, Utah will become more important as an agricultural producer, but it is well to remember that only a small portion of the state can ever be irrigated.

LIVESTOCK

While stock raising has not the relative importance in Utah that it has in Nevada, yet this state surpasses its neighbor in the number and value of its livestock. The total value of the stock within the state was $48,018,867 in 1925. Sheep raising is the most important item both as to numbers and value. In 1925 there were 2,355,038 head of sheep within the state and these produced between eighteen and nineteen million pounds of wool. Cattle raising ranks second in importance, and over half a million head were to be found in 1925. This included over 71,000 dairy cows and here, as in Nevada, the number of dairy cows has been increasing steadily within recent years. Horses rank third in importance, there being 110,172 head with a value of $5,155,772 in Utah in 1925. Sheep, cattle, and horses are extensively grazed on the open range, consisting of Federal and state lands, and are frequently taken up into the mountains for summer pasturage. Some grazing is done within the National Forests included within the state. Poultry is an item of livestock which has recently been increasing rapidly in importance. The value of the chickens raised in 1924 was $933,074 and the value of the eggs produced in that year was $2,518,304.

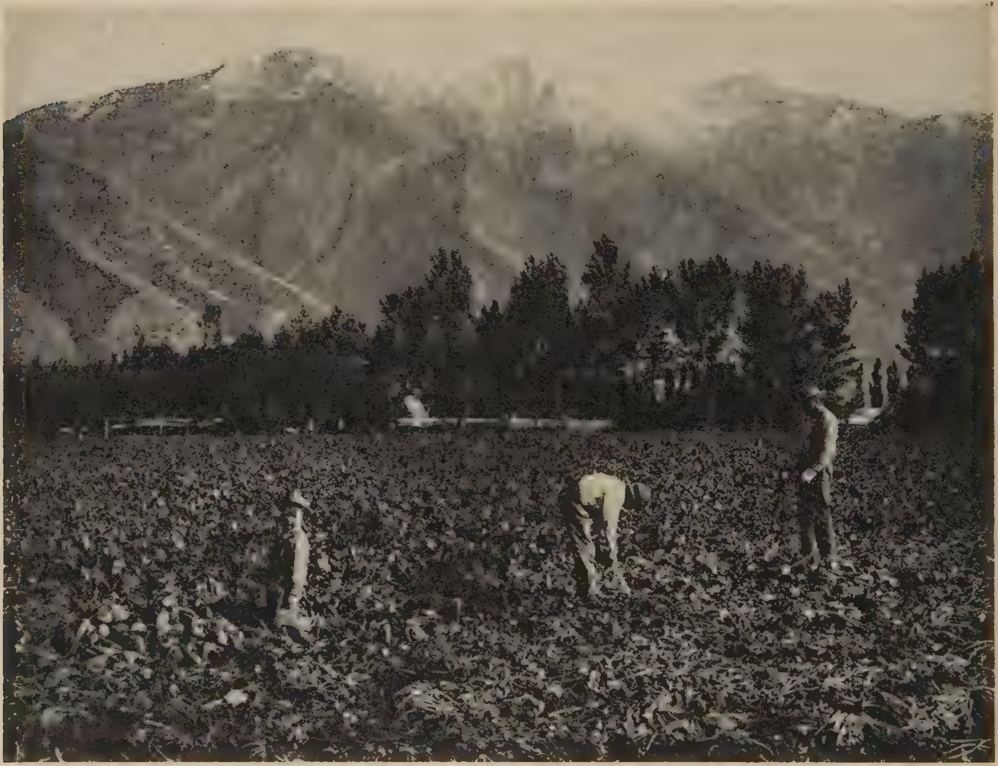

FIGURE 9.—Digging sugar beets on Mapleton Bench, Strawberry Valley Irrigation Project, Utah. (Courtesy of Bureau of Reclamation, U. S. Dept. of Int.)

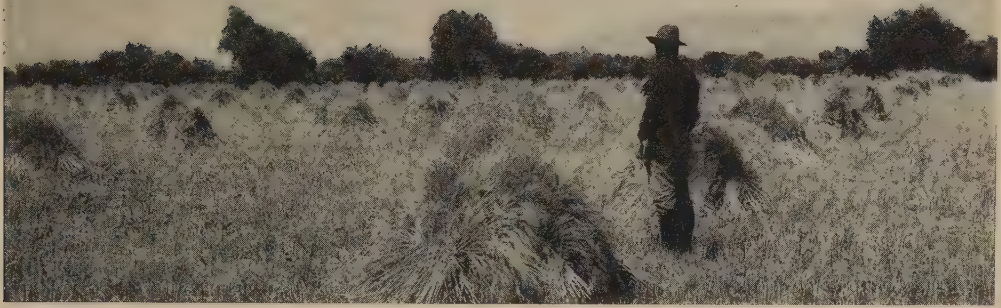

FIGURE 10.—Barley produced under irrigation near Provo, Strawberry Valley Irrigation Project, Utah. (Courtesy of Bureau of Reclamation, U. S. Dept. of Int.)

Mules, goats, and swine are also raised in some quantities. Stock raising is thus found and will continue to be found in those sections of the state which are too dry for the production of crops. However, within recent years there has been an increasing amount of livestock raised in the irrigated districts in connection with diversified farming. Even the large ranches irrigate considerable acreages of alfalfa which is fed to the stock during the winter.

MINING AND QUARRYING

Mining is the second most important industry in the state and Utah ranks eighteenth among the states in the value of her mineral products. The Basin ranges of Utah are rich in ores and new deposits are constantly being opened up. In 1927 Utah ranked first among the states in the production of silver, furnishing 32.05 per cent of the nation's total; second in copper, producing 15.48 per cent of the nation's total; second in lead, producing 22.42 per cent of the nation's total; and sixth in gold, producing 8.85 per cent of the nation's total. The largest open-cut copper mine in North America is located at Bingham, twenty-five miles from Salt Lake City. The state also contains the largest silver mines in the United States. The production of the various minerals fluctuates from year to year, depending upon the working-out of old deposits, the opening up of new ones and variations in market prices. For example, the total value of the gold, silver, copper, lead, and zinc rose to $99,328,155 in 1917, fell to $22,023,790 in 1921, and gradually rose again to $82,662,884 in 1926.

Considerable deposits of bituminous coal are to be found within the state, but mostly within areas not included in the Great Basin. The United States Geological Survey estimates that 13,130 square miles have workable coal deposits and estimates that these deposits contain some 196,000,000,000 tons. The annual production today is around 4,750,000 tons and is increasing steadily.

In southwestern Utah, in Iron and Washington Counties, are important deposits of iron ore. The United States Geological Survey estimates that development work has disclosed 40,000,000 tons of ore, and estimates as to the total amount run as high as 1,000,000,000 tons. These deposits have only been worked extensively since 1922 and their production should increase yearly.

Utah contains large deposits of fine building stone. Granite, sandstone, and marble are quarried extensively. There are also large deposits of gypsum which is used in the manufacture of the so-called "hard wall plasters." Large amounts of natural gas have been found and there are indications of oil though little has been produced up to the present. The United States Geological Survey estimates that there are 92,159,000,000 tons of oil shale in the state which should yield nearly 15 gallons to the ton. Extensive deposits of potash are also found, but at depths too great to make mining profitable at present. Salt is mined from open cuts in Sevier and Sanpete Counties, but the principal production comes from the waters of the Great Salt Lake. It is estimated that this lake contains 400,000,000 tons of common salt and considerable amounts are taken from it each year.

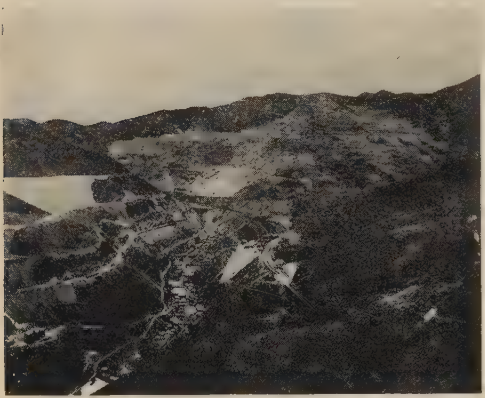

FIGURE 11.—Open cut copper mines at Bingham, Utah. (Courtesy of Richard N. Hunt.)

From this discussion it is clear that Utah is favored in having valuable and extensive mineral deposits. In the production of gold, silver, copper, lead, and zinc, the state is among the foremost in the country and the production of the last three minerals is increasing rapidly. The coal deposits furnish an ample source of power and will become increasingly important in the future. Iron ore should play an important part in the future industrial development of the state. The production of building stone, gypsum, and salt seem likely to maintain their present importance at least. Such minerals as oil shale and potash offer tremendous possibilities for the future. With the exception of a majority of the coal, all of these minerals are produced within the Great Basin and are typical of important deposits to be found within that area.

FORESTS

Utah contains forest areas of considerable extent, but in these areas, because of the arid character of the region, the growth is not heavy and the trees are not of particularly valuable types. The majority of these areas are contained within National Forests which occupy seven and one-half million acres throughout the state. It is estimated that these forests contain between seven and eight billion feet of timber. The trees most commonly found are the western yellow pine, lodgepole pine, Engelmann spruce, Douglas fir, and white fir. The majority of this forest is found among the Wasatch Mountains, and its value lies not only in the actual timber produced but also in its affect upon the stream flow from this mountain area.

By far the majority of the Basin ranges are desert and support only a scanty growth of sagebrush and juniper. However, a few of the ranges which are sufficiently high to receive moisture have an open forest growth. These ranges have an upper and a lower timber line; the position of the upper timber line is determined by cold and that of the lower line by the lack of moisture. Although sufficient timber is found to supply the needs of those living within the Great Basin, aridity will prevent this from ever becoming an important timber area.

MANUFACTURING

Although Utah has two factors necessary for successful manufacturing, namely, power and raw materials, it lacks at present extensive markets and a large labor supply. For this reason the industrial development of the state has been slow, and it normally ranks about fortieth among the states in this respect. The position which manufacturing holds is shown by the fact that the estimated value of the manufactured products of the state in 1927 was $325,000,000.

The principal types of manufacturing are those which utilize the raw materials of the state. In order of importance they are smelting, beet sugar refining, slaughtering and meat packing, and milling. Recently, also, the canning industry has been increasing in importance. Of this group the smelting and the beet sugar industries stand out as particularly important.

The manufacturing of the state has shown steady progress during recent years, and although Utah will in all probability never become an important manufacturing section, its progress in this connection will continue as population increases, new markets open up, and additional amounts of raw materials are produced.

The majority of the manufacturing of the state is to be found in Salt Lake City, Provo, and Ogden. These centers contain the only important manufacturing to be found throughout the Great Basin.

SUMMARY

Utah presents an example of the most effective use that can be made of the resources of the Great Basin. The thrifty and industrious population of the state have so utilized those resources as to produce a stable and prosperous community. It serves as an example which other sections of the Basin area might well follow.

Utah should develop in many lines, its mining industry is growing and should continue to grow, it can expect a moderate development in manufacturing, stock raising will become more important with the increased introduction of high-grade stock, and its agricultural development will continue as more and more land is irrigated. From five to ten million acres of land can be irrigated and this is being done as rapidly as possible. Thus, the future of Utah is indeed bright and holds great promise, but it is well to remember that here, as in Nevada, much of the land must remain a desert, unoccupied, and of little value to the rest of the state.

TRANSPORTATION

The growth and progress of Nevada and Utah, as of other sections of the Great Basin, have depended upon the development of modern transportation facilities. Prior to the construction of the railroads only the most precious metals were of sufficiently high value to bear the extremely heavy transportation costs to markets. All other products, both agricultural and mineral, had to depend upon local markets which were obviously small. Also, prior to such construction, it was impossible to bring into the Basin essentials demanded by any considerable population and which could not be there produced. Thus, it was not until modern transportation facilities were provided that the Great Basin could secure the essentials for any considerable population or exploit the natural resources which it contained.

Today several great railroads and their subsidiaries give access to those portions of the Basin most suitable for agriculture and to the more important mineral-producing regions. These roads are the Union Pacific, the Southern Pacific, the Western Pacific, the Santa Fé, and the Denver and Rio Grande Western. The latter two, however, tap only small parts of the area. Large sections of the Great Basin, however, have no access to rail transportation and it is probable that this condition will continue to exist as many portions are so sparsely populated and produce so little that it would be unprofitable to construct railroads to them. Nevertheless, the railroads which have been constructed have made possible the development already described as they have enabled the producing areas to get their products to markets and have made it possible to secure supplies from the outside.

Four electric lines, centering around Salt Lake City, also serve part of the region.

Recently modern highway construction has advanced rapidly near the centers of population and such well-known interstate highways as the Lincoln Highway, the Victory Highway, the Zion Park Highway, the National Old Trails Highway, and the Highland Trail cross portions of the area. These roads add to the prosperity of the Basin by putting new sections into communication with markets and supplies.

Recently, also, air transportation has developed rapidly. Salt Lake City has become a center for numerous air routes connecting it with cities in all directions.

Thus the railroads, both steam and electric, the highways, and the air routes have made many sections of the Great Basin accessible and have played no small part in bringing about such development and prosperity as the area has attained.

CONCLUSION

The Great Basin is and will continue to be one of the most unique and picturesque sections of the United States. Its extreme aridity, due to the mountain barriers on each side, and its interior drainage system set it apart from all other sections of the country. The Great Salt Desert, the Mohave Desert, Death Valley (the lowest portion of the Basin), and the Basin ranges themselves are also sights which cannot be found elsewhere on the continent. Much of its area is and must always remain a desert which will be of little importance outside of its scenic beauty. The development within the state of Utah well illustrates the future lines of progress for those sections where development is possible. These lines are the continued development of the mining industry, the development of agriculture through the irrigation of all lands for which water is obtainable, the development of the livestock industry by the raising of high-quality stock on those sections which are sufficiently moist to support some grass growth, and the development to some slight extent of manufacturing to supply local needs and to utilize local raw materials.

However, to really know the Great Basin and to feel its spell, one must not only visit the more densely inhabited sections of Utah and Nevada but must venture into its wilder and more remote desert portions. To slowly melt under a noonday desert sun; to lie in the chill of a desert night and to watch the millions of brilliant stars which seem almost within arms' reach; to see in the distance a cool and inviting lake and after wandering long in search of it to discover that it is but a mirage and to know that on such an occasion it is only a full water bottle that spells the difference between amusement and tragedy; to come suddenly around some rocky corner upon an old prospector and his burro and to stop for a few minutes while he expertly aims a stream of tobacco juice at a nearby puff adder and tells of his next strike; to do all of these things is to know the desert and without them one can little imagine its fascination. It is the desert which is and always will remain the principal part of the Great Basin, and it is difficult for those who have never visited it and who have only the background of the highly civilized centers of the east and the middle west to visualize it. But it is there, eternal, silently weaving its web of mystery and fascination, ever alluring, ever repelling, it is the spirit of the Great Basin.

THE SUGAR INDUSTRY OF MAURITIUS

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MAURITIUS, once primarily important to the British Empire as a strategic outpost in the Indian Ocean, owes its present-day significance to its position as the leading source within the Empire of Great Britain's imports of raw sugar, its exports of this commodity to Great Britain and Northern Ireland in the last few years having been exceeded only by those of Cuba, the world's leading producer. In the quinquennium, 1923–1927, while Cuba's proportion of our imports was 35 per cent, that of Mauritius was 14 per cent. In the same period the average annual production of Mauritius was 216,000 metric tons, of which an average of 165,000 came to this country. In attaining this level of production this little Colony of 705 square miles, much of it mountainous, has become an extreme example of a one-crop country. Sugar is indeed "la mère nourricière du pays." In the years following the War, sugar cane has occupied up to almost 80 per cent of the cultivated area, comprising the best lands. In 1921–1926 sugar accounted for 96 per cent in value of the total exports excluding specie. The determining influence of the crop on the life of the island is shown by a comparison of the course of sugar exports with that of the Government's revenue, and this only reflects its influence on all the activities, economic and social, of the Colony. Here, too, as in other "sugar colonies," those who control the industry have exerted a strong influence on local political affairs. While the Government augments its revenue in years when the sugar market is favourable, it has, on the other hand, rendered assistance from time to time to the industry on which its finances depend.

Distribution

The sugar cane was introduced by the Dutch but not cultivated commercially until after 1735.[1] It now occupies the greater part of the coastal districts of Savane and Grand Port on the southeast, the plains of Flacq on the east, and much of the northern districts of Rivière du Rempart and Pamplemousses, while a belt of cane estates runs across the central plateau, following the line of the more northerly of the two railways crossing the uplands. There is also a much smaller irrigated area in Black River near the west coast. Of the total area under cane over two-thirds are below the 600-foot contour, the higher districts which occupy over half the island being less favourable because of heavier rainfall and lower temperature.

RELATION TO CLIMATIC CONDITIONS

The sugar cane grows within wide limits of annual rainfall. In Mauritius approximately two-thirds of the total crop are grown between the annual isohyets of 50 inches and 100 inches. On the plateau precipitation is for the most part greater, the area of maximum lying rather to the south and east, facing the trade winds, which in summer blow from

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[1] A. Walter in Macmillan's "Mauritius."

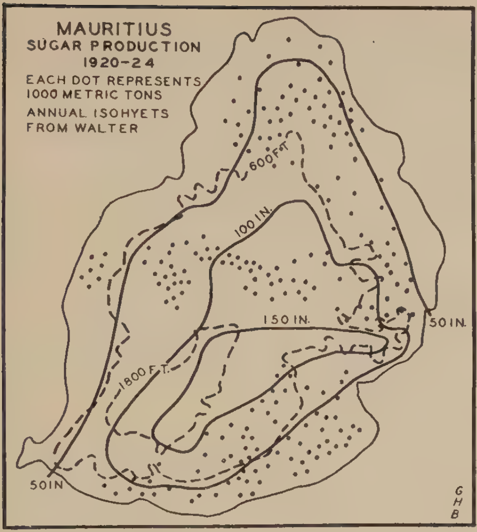

FIGURE 1.—Sugar production in Mauritius from 1920 to 1924.

east and east southeast, and in winter from east southeast and southeast. The eastern coastlands are thus hot and humid, the southeast being so even in winter, and Grand Port and Flacq in the south and east having the greatest area under cane. The western coastal areas are markedly drier, particularly in the Black River district, the precipitation there being 32 inches, falling chiefly in the period January to April, only 60 per cent being effective. Sugar cane is, however, grown in this district by means of irrigation. La Ferme Reservoir, completed in 1921, irrigates 3,000 arpents. La Nicolière system, in the North, which suffers from large fluctuations in yield, will irrigate over 10,000 arpents when its three connected reservoirs are completed. As usual, in irrigated areas, comparatively high yields have been obtained, the Black River district having two tons per arpent more than the average for the island.[2]

For sugar cane a wet season with fairly evenly distributed precipitation is necessary to secure a good yield of cane, while to ensure a good yield of sugar this should be followed by a dry season in which the sugar-content of the juice is increased. In Mauritius the well-marked alternation of wet and dry seasons due to the annual migration of the wind-belts is thus favourable to sugar production. The summer rains begin in December and rise to a maximum in March, after which there is a sudden falling-off in April and then a steady decrease in precipitation to the minimum in September. The sugar cane is perennial, producing for many years in succession fresh offshoots from the mass of underground stems, the first season's cane being known as "plant cane," the succeeding offshoots as "ratoons." The number of years for which ratooning is allowed to go on varies in different countries. In Mauritius about four-fifths of the crop in any year is from ratoons.

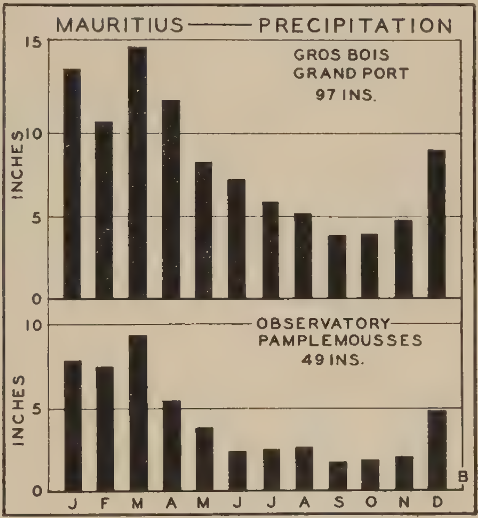

FIGURE 2.—Typical rainfalls for the wet Southeast (Grand Port) and the drier Northwest (Pamplemousses) in Mauritius. (Data from Walter, On the Influence of Forests on Rainfall. Period 35 years.)

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[2] Mauritius Dept. of Agric., General Bulletin, No. 6.

The growing-period of the ratoons covers approximately the 12 months of the calendar year. About 75 per cent of an individual ratoon crop is produced in the four months of high temperature, January to April, when growth is very rapid. At this time, too, the crop is getting the summer rains. There is a rapid falling-off in rate of growth with the fall in temperature in the succeeding months. Ripening takes place in the relatively cool winter months from June onwards. The range of monthly mean temperature in Mauritius is from about 26.5° C. in February to about 20.5° C. in August. There is no danger of frost, which is the chief consideration in regard to the relation of cane to temperature.

Practically all the plant cane is also harvested by December, after a growing season eighteen to twenty-two months, the Grande Saison. This cane gets the benefit of two rainy seasons and undergoes a resting period during the cool dry season from July to September of the first year, particularly in the higher districts where the cool season is more pronounced. There the plant cane takes longer to mature. In the northern lowlands it is ready, however, in thirteen to fifteen months and is harvested at the beginning of the crushing season in August, having been planted in April to June of the previous year. This is the "Petite Saison." This cane is sufficiently established to resist the first dry season and grows mainly in the following summer. The practice varies not only with climate but with soil, labour, and other local conditions, and there are transitional forms, such as "Demie Saison," with a sixteen to eighteen months' growing period, also harvested by the end of the calendar year. The highest yield comes from the "Grande Saison" crop, thus compensating for its greater time in the ground and the additional cost in cultivation. June is regarded as the best month for planting, the yield not only of the plant canes but of the subsequent ratoon crop being reduced if planting is delayed until after August. From the last days of July onwards, cane is being harvested in some part of the island, beginning on the northern lowlands with the "Petite Saison" crop, the main bulk of the total crop being crushed in the last three months of the year and the campaign being generally completed by the end of December.

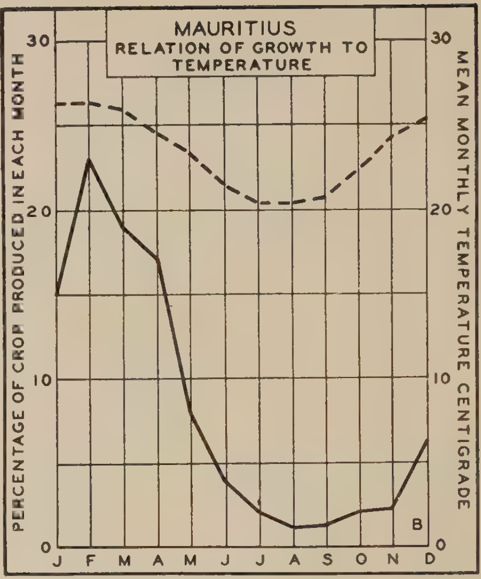

FIGURE 3.—Ratoon crop, maturing in twelve months, in Mauritius. (Data from H. A. Tempany, Mauritius Dept. of Agric., Gen. Bull. No. 36. 1926. Page 31.)

In a detailed study[3] of rainfall in relation to yield of sugar, M. Koenig has shown that it is not the heavy summer rains of January–March that are important but the rainfall in

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[3] Mauritius Dept. of Agric., General Bull. No. 27, pp. 11–12.

June and July (especially the latter) preceding the harvest, and that in November–December (especially the former) in the preceding year. A definite positive correlation has been established between the rainfall, or, still more precisely, the degree of wetness (which allows for the number of days during which rain falls), and the subsequent yield. Deficiency of rainfall during these critical periods cannot be subsequently compensated for. Similarly, in temperature, March has been shown to be the critical period.

The most calamitous vagary of the weather to which the island is subject is the particularly violent cyclonic storms that are especially prevalent in February and March. Although the paths of these storms, which are formed mainly in the area of intense heat to the north and northeast, very rarely pass over Mauritius, they occasionally pass sufficiently near to cause considerable damage, an approach to within 50 or 60 miles being dangerous, since the wind then blows with violence. The most disastrous of comparatively recent times were those of February 12 and April 29, 1892, the two together destroying 48.3 per cent of the sugar crop.[4] Next to these comes that of February, 1902, which destroyed 18.2 per cent; since then severe cyclonic damage has occurred in 1911, 1916, and 1926. The curve of annual production shows their incidence clearly. But, it is only when cylcones pass too near the island that their rôle is destructive; normally they are beneficial, for in their absence the rain-bearing winds are weak, and it has been found that droughts generally occur in years of weak cyclonic circulation. Despite the serious damage experienced by the sugar crop through cyclones, the exposure to cyclone risk has been one of the factors favouring the predominance of sugar cane in the island, owing to the relatively greater resistance offered to the wind by the cane as compared with other crops.

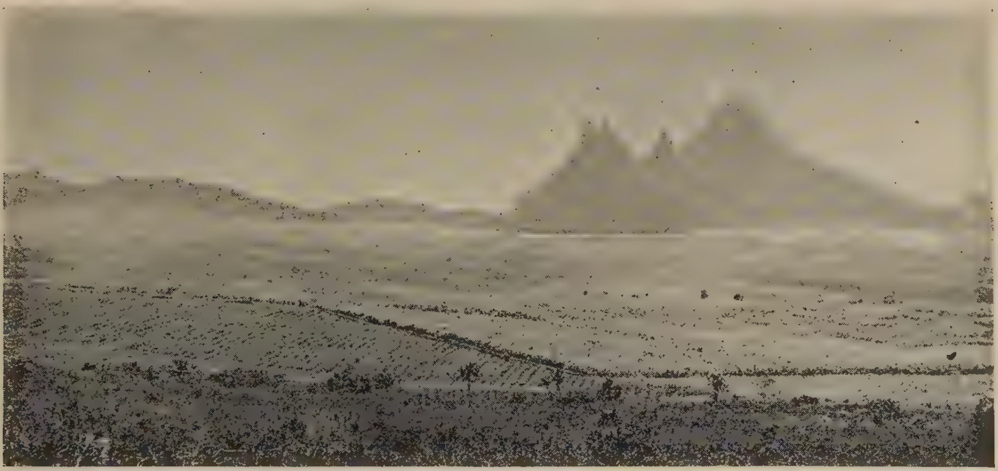

FIGURE 4.—Les Trois Mamelles, Mauritius. The picturesque remains of volcanoes rise from the cultivated plains of the interior. (Courtesy of Imperial Institute, London.)

The other natural calamity to which Mauritius is most subject is drought. Since that of 1886 droughts have been serious in 1897, 1907, 1921. Their effects have been, however, relatively less than those of cyclones. Naturally, it is the marginal districts of the west that are most susceptible. These districts, too, have suffered most from the destruction of the forest, a destruction itself mainly carried out to extend the area under cane.

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[4] Mauritius Almanac, 1925–1926, p. E. 39.

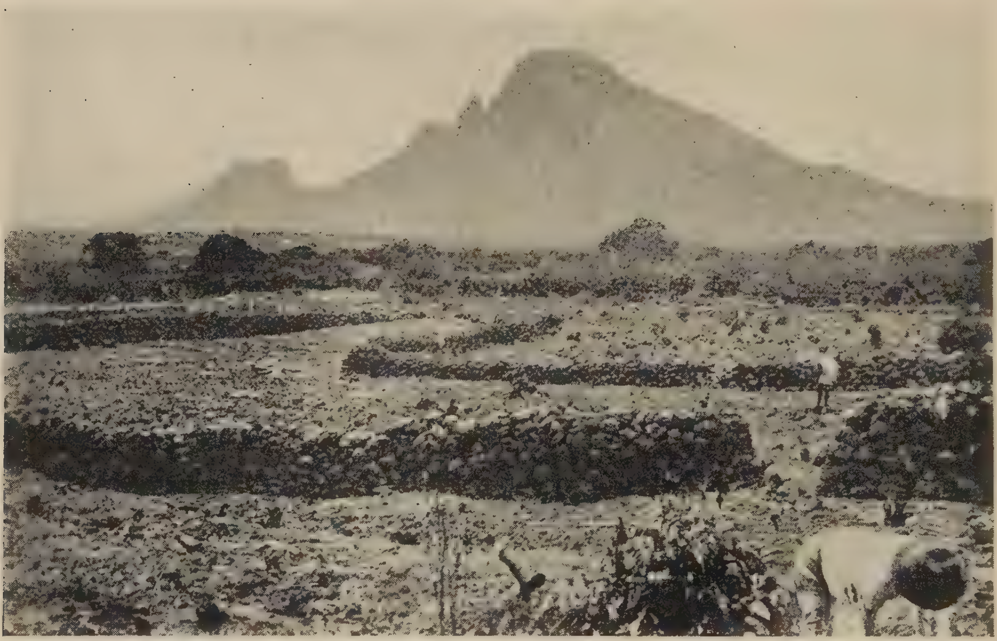

FIGURE 5.—In the drier north of Mauritius, the lava sheet has weathered into large boulders which are a serious hindrance to mechanical cultivation. The boulders are collected in long walls following the contours. (Courtesy of "Empire Production.")

SOILS

The sugar cane, though adaptable to a varied range of soils, thrives best in those that are not only fairly rich but well drained, while ease of working is a particularly desirable feature in countries where labour is scarce. In Mauritius, practically all the cane is grown on the Red Soils, which cover the greater part of the island save in the west and part of the north, where Black Soils occur. The Red Soils, as elsewhere in the Tropics, are the result of prolonged weathering, in conditions of great heat and moisture, of the parent rock, here a basic lava. These soils are fertile loams, of great moisture-retaining capacity, but at the same time open and very easily drained. Drainage is also greatly assisted over a large part of the Colony by the relief. They are easily cultivated even after heavy rain, which is also a matter of great importance for the sugar cane. Thus, their physical qualities as a whole make them particularly suitable for cane-growing.

In Mauritius the Red Soils are divided into three types:

(1) The Free Lands are those on which the most intensive cultivation is carried on, and they represent the Red Soil in its normal condition. They cover, roughly, a great part of the southeast (Grande Savane, and

parts of Grand Port and Flacq) and the open plains of the central district of Moka, an area where over half of the acreage and about two-thirds of all the production are found. The yields reach up to 40 to 60 tons, and even up to 70 tons per arpent. Savane, Moka, and Flacq are the districts in which the highest average yields of cane are obtained.

(2) In other parts of Flacq and in Pamplemousses the Gravelly Lands predominate. These also are very good, particularly as regards drainage. In fact, their rapid-drying qualities may become a danger in very dry years.

(3) Still more to the north the Rocky type is found. Here, in the comparatively dry part of the island, the lava sheet has weathered into large blocks. While the soil is consequently difficult to cultivate and presents a serious hindrance to implemental cultivation, the rocks have not entirely proved a drawback in that they help to prevent evaporation, a considerable advantage in the drier north, and also to maintain the temperature. As a result of the greater expense in cultivation, ratoonage is prolonged.

The Red Soils are rich in iron, in the form of oxide, very poor in lime and in potash, and extremely poor in phosphoric acid. Leaching takes place rapidly. Intensive cultivation soon led, therefore, to the need for fertilisers, and today the Mauritius cane lands are heavily fertilised, practically all the growers, including the Indians, being alive to the need for maintaining fertility at a high level. Although the lime-content is small the addition of lime is not as a rule necessary, very little lime being required by cane. The deficiency in phosphoric acid soon, however, became a limiting factor, and led as early as 1845 to the introduction of guano. This proved an important stimulus to production and the response, as seen in the subsequent rise in total production, was rapid. The nitrogen-content is very high, a very great advantage, and the soils are rich in nitrogen-fixing bacteria. The organic content of the soil has long been very carefully maintained, stable manure and factory waste being regularly applied with very beneficial results, while the use of molasses as manure, particularly for plant cane, has been practised since 1860 and has been a general characteristic since 1900. Not only does the molasses supply plant food, its potash content being particularly important, but it has a sterilising effect on harmful organisms and also improves the condition of the soil. The

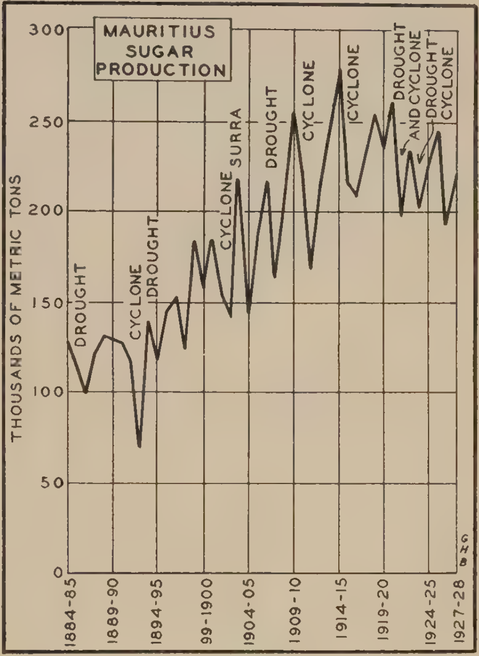

Figure 6.—Sugar production in Mauritius. (Data from Geerlig: "The World's Cane Sugar Industry," and Reports of Mauritius Dept. of Agric.)

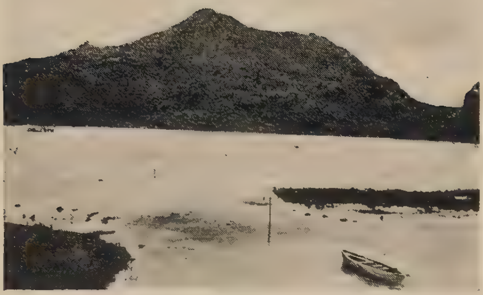

FIGURE 7.—La Ferme Reservoir in the dry West of Mauritius is formed by diverting the surplus water of two streams and irrigates over 3,000 acres. (Courtesy of "Empire Production.")

practice of turning in legumes into the soil, as a means of maintaining the nitrogenous content, is also a well-established and characteristic feature of Mauritius cane agriculture, chiefly *Phaseolus lunatus* and *P. vulgaris* being used. The subsoils are peculiarly infertile and thus the average depth of cultivation is as low as 10 inches. The danger of turning up this infertile layer is a serious hindrance, and it has been suggested that the introduction of the disc plough may in this way have lowered the yields.

The Black Soils occur in the west and north, in districts where the annual precipitation is less than 50 inches. These compact soils present difficulties, apart from their coincidence with relatively arid conditions, which have been obstacles to the spread of cane cultivation.

CRITICAL IMPORTANCE OF THE LABOUR FACTOR

The climatic and soil conditions have favoured the predominance of the sugar industry but here, as in the British West Indies, its development has been possible only by the introduction of East Indian labour. The European population, in all only about 20,000, mainly of French descent, does not engage in manual labour, while the rest of the non-Indian population is for the most part engaged in general services of a non-agricultural nature. Since the abolition of slavery in 1834 and the final liberation of the negro slaves in 1839 the sugar industry has relied on India for its labour supply. The annual net immigration of Indians has throughout the century of its history shown large fluctuations. It reached its maximum in 1854, though the proportion of Indian immigrants in the total population did not reach its highest peak until 1861. Thereafter, the Indo-Mauritian population, that is, the Indians born in Mauritius, gained. The increased restrictions of the Labour Law of 1867 marked the end of the period of greatest influx. In that year, for the first time since the beginning of Government regulation of immigration in 1842, there was a net emigration, and since then there have been only minor fluctuations to either side of the migration balance. In 1910 assisted immigration was discontinued, the direction of the Colonial Office, after the Royal Commission of 1909 having declared its opinion that the Indian population of the Colony was sufficient, if all were employed. Eleven years later, according to the 1921 Census, the Indian population numbered 264,537, or 71 per cent of the total population. There had been a falling-off not only in the quantity but in the quality of the immigrants, and this was coincident with increasing prejudice in India against emigration to the Colony and indentured emigration in general.

The labour problem originates, however, from causes operating

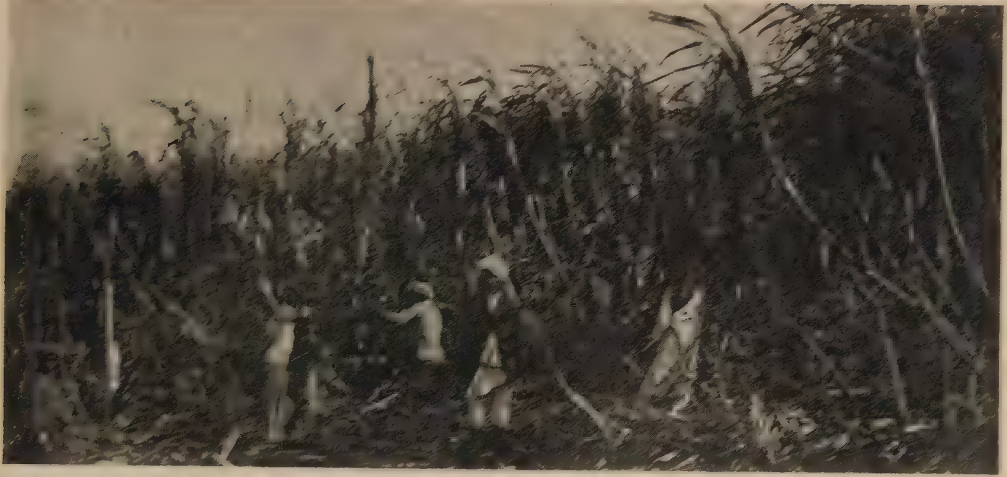

FIGURE 8.—East Indian labour in Mauritius. Cane cutting—the men cut the cane, the women and children strip off the leaves. (Courtesy of Miss M. I. Freeland.)

within the Colony. In the first place the normal growth of an immigrant population has led to a decrease in the proportion of the effective labour-force to the whole, since the proportion of males to females has decreased, and there being also a greater proportion of old people. Amongst economic causes the chief is the progress of "morcellement," the breaking-up of the estates into small holdings, which results in a scarcity of hired labour on the remaining estates. The rapid extension of this process began after 1910, under the stimulus of low prices, many of the estates selling land to former labourers on easy terms, usually on condition that the land remains under cane. In this way the proportion of cane land held by Indians increased from 30.3 per cent in 1909 to 43.1 per cent in 1917, and then more slowly to 46.2 per cent in 1922. Much of the increase in cane area in the post-war boom years took place on Indian lands. Morcellement proceeded most rapidly on the relatively inferior lands of the drier north and in those parts of Grand Port and Savane where transport conditions are less satisfactory. Co-operative credit societies have assisted and stabilised the process, especially in these more difficult areas. The Indian population living on the sugar estates has been declining rapidly, and at the end of 1925 only 25 per cent was on the estates. The number of able-bodied Indian males between the ages of 20 and 49, who are essential for the heavy work on the estates, has been declining still more rapidly. The scarcity of labour was accentuated in the post-war boom years, when on the one hand the estates were anxious to get more labour to extend cultivation while prices were high, and on the other hand the high prices for cane enabled many of the small Indian planters who had formerly eked out their living by hiring themselves out as labourers to cease doing so. Many Indian women, too, who had formerly worked in the fields, now stayed at home, while the higher wages enabled those men who still worked on the estates to work fewer days. The after effects of the terrible influenza epidemic of 1919 were then felt, too, with great weight. Further negotiations with the Indian Government on the migration question were stimulated during those years, but without satisfactory agreement.

The proportion of the Indian population engaged in agriculture generally has been declining, too, from its maximum in 1881 at an increasing rate in each successive decade. There has been a drain of the agricultural population in the chief town, Port Louis. The Mauritius Government's own vigorous public works policy has itself increased the possibilities of non-agricultural employment, thus accentuating the difficulty.

Since the areal limits of sugar production have been reached, the operation of labour shortage as a limiting factor is felt because of the difficulty of intensifying cultivation and raising yields. It is, however, difficult to separate the effects of labour shortage in this respect from those of the progressive "morcellement" and corresponding increase in the area of operation of the relatively inefficient small planters. Total production in the staple industry has continued to increase at a rate sufficient to cause quantitative production per head of population to also increase, but in both cases there has been in recent years a slowing-down. As demand for labour has continued during this period, it is evident that the product can still find a market, so that the optimum population has not fallen. It cannot, however, be said that the actual population is below what would be the optimum, assuming that it were working at normal efficiency. The temporary decline in efficiency due to the increase of peasant proprietorship may be adequate to explain the tendency of the rate of increase of production to decline. If this is so, the introduction of fresh immigrant labour, even were it available, would be inadvisable especially in view of the industry having reached its areal limits. The solution of the difficulty will eventually come by increased output per head as efficiency increases.

The labour problem is being partly met in Mauritius, as elsewhere, by the increased use of agricultural machinery on the estates. The use of the tractor has extended rapidly in the last few years under the stimulus of rising costs, until by the end of 1926 there were 117 in use.[5] Hindrances to this development are that the tractors are not yet adapted by the makers to Mauritius conditions, a drawback that will doubtless be removed as the market grows; the deficiency of skilled labour essential for the further mechanisation of agriculture; the small size of the fields and rocky nature of much of the surface in the north; and the extension of peasant proprietorship which enhances the obstacle of initial cost. On the other hand, the tractor permits more rapid work and can use the power alcohol which is a potential by-product of the molasses. Plough-driven furrows are replacing the old hand-dug cane-holes, and subsoiling ploughs are in use for after-cultivation. P. de Sornay quotes figures [6] which show that the use of the plough reduces labour costs by 42 per cent in the case of plant cane and by 36 per cent in ratoons.

A more gradual but far-reaching line of attack on the labour problem

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[5] Mauritius Dept. of Agric. Ann. Rept. for 1926.

[6] P. de Sornay, *La Canne à Sucre à l'Ile Maurice*, 1920, p. 642.

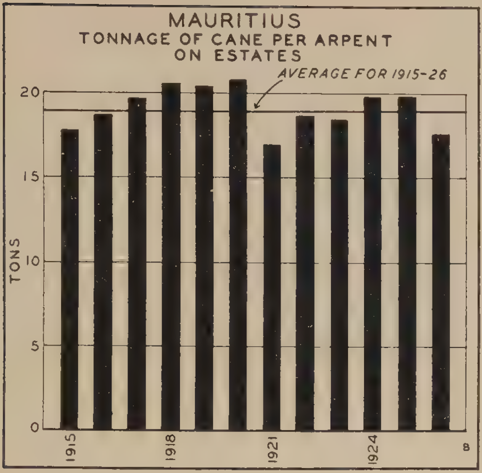

FIGURE 9.—Tonnage of cane per arpent on estates in Mauritius.

is in the direction of improved public health. The density of population—538.5 to the square mile in 1924—makes sanitation a difficult problem. As in most other parts of the Tropics, the diseases that have the most deleterious effect on the economic life of the community are malaria and hookworm. Dr. A. Balfour, in his report of 1921,[7] stated that "despite the many natural advantages of the Colony, its general unhealthiness had reached a degree unparalleled in any similar tropical Dependency of the Empire." He concluded that the chief weapon in the difficult task of rendering the island healthy would be education. The malaria problem is rendered difficult by the fact that at least three species of Anopheles mosquito, with different habits, act as vectors. Favourable breeding places are abundant on the sugar estates. The Government has initiated an energetic campaign against the mosquitoes. With the other scourge, hookworm, examinations hitherto made indicate that about three-quarters of the population is infected, the proportion of infection on the sugar estates, and especially on those of the more humid districts, is probably much higher. Largely due to the campaign initiated by the Rockefeller Foundation, treatment is being widely adopted, and experience elsewhere in the Tropics has shown that the effects of such measures on efficiency are immense.

DEVELOPMENT OF PRODUCTION

The total production of sugar in Mauritius showed an upward trend from the eighties to 1914, when the maximum thus far of 277,400 metric tons was reached; since then the trend has been downward. The area under cane rose to 172,000 arpents in 1921, under the influence of high prices; in that year, however, drought reduced the crop seriously. The downward trend in area since has been at a rather more rapid rate than the rise in the corresponding previous period. Since most of the best land was already under cultivation, the rise in area to 1921 occurred mainly on inferior lands, chiefly in the north, where the soil is poor and the climate dry. In the Black River district a very considerable increase took place on the irrigated lands of La Ferme. It was almost entirely virgin land that was brought under cultivation at this time. As so much of this was of definitely inferior type average yields fell in these years. The downward trend since has represented merely the abandonment of these lands when prices no longer made it possible to cultivate them economically. The total of possible permanent expansion of the cane area—in the irrigated districts—is small and unlikely to raise permanently the total cane area much beyond the 1921 maximum.

The other line of possible increase

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[7] Balfour, A. Rept. p. 1.

in total production is by raising the yield per unit area. While there has been a rise in the standard of cultivation on the estates, this has been neutralised by the steady decrease in the area cultivated by them. Although the Indian planters are not unprogressive the small scale of their operations, lack of capital, personal inefficiency, all operate to cause their standards to lag behind. A serious feature in the situation is the diminution in the sugar-content of the canes; Mauritius is steadily losing its superiority over Java in this respect. This diminution has proceeded at a rate sufficient to counterbalance the increased efficiency of the factories in the extraction of sugar.

Mauritius has come to be dangerously dependent on one variety of cane—White Tanna—which by 1925 had spread over 58 per cent of the total cane area. Its popularity is due to its disease-resisting powers and to its being equally adapted to both upland and lowland districts. In spite of this considerable reliance on one variety of cane and to the long-continued and little-interrupted occupation of the soil by cane, the Colony has, however, been fortunate in its freedom from serious cane diseases. The most serious pest is the cane-borer (*Phytalus Smithi*).

Under the influence of increasing competition from Europe and from other tropical sugar producers, the manufacture of sugar has, since 1863, been steadily concentrated on a diminishing number of factories. Here as elsewhere, too, the business of cultivating the cane is being steadily separated from that of manufacturing the sugar. The proportion of the cane area cultivated by the factories decreased from 46 per cent in 1911 to 31 per cent in 1925. Despite the great decrease in number of factories that has occurred, the concentration of production has lagged behind the necessities of the country. The size of factories in Mauritius is still very small in comparison with that in the chief sugar-producing countries. Centralisation of the production of sugar for each district on one factory, which is the modern road to economic production, demands more capital than is readily available in the Colony, where the European population clings to the Catholic tradition of large families and the French tradition of equal inheritance. Costs of production are relatively high as compared with those of the great producers of raw sugars. Even the best Mauritius factories do not attain the average efficiency in the extraction and recovery of sugar of Java and Hawaii, and competition between the relatively numerous factories for cane raises the price of their raw material.

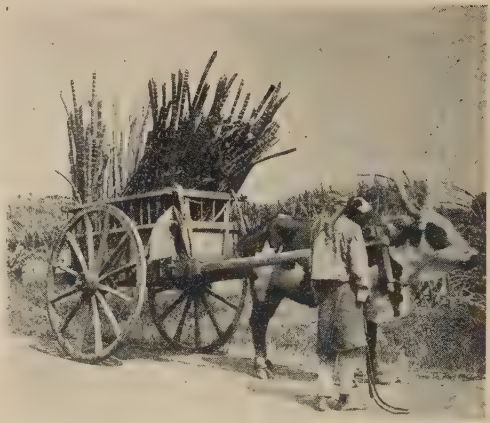

FIGURE 10.—Older method of transporting cane to factory by bullock cart in Mauritius. The small growers still send much of their cane by road. (Courtesy of Imperial Institute, London.)

INFLUENCE OF THE MARKET

The wider aspects of competition in the world market are bringing about a change in the products of the industry. Before the War India was the chief market for Mauritius sugars, generally taking over 60 per cent of the production. The remainder was divided between the United Kingdom, which was taking a gradually increasing proportion even then, South Africa, Australia, and Hong-Kong. With respect to the Indian market the island had the advantage of comparative proximity and relatively easily available freight facilities, most of the inward freights being from that country. So long as this market was dominant raw sugars of about 96° polarisation remained the chief product. During the War and in the years following, the bulk purchases of the British Royal Commission on the Sugar Supply diverted practically the entire crop to the United Kingdom. Since then, save in 1924, the Indian market has never regained its former preëminence and Great Britain has absorbed almost the entire output, Australia and South Africa having meanwhile become self-supporting and protected their home production by means of embargo and high tariff respectively. With this change in the situation, the Mauritius manufacturer has been encouraged to increase his production of direct-consumption white sugar of about 99.5° polarisation to suit the higher tastes of the British market, and so enters into competition with the British refiners, who formerly worked up the whole of that portion of the Mauritius export reaching the British market. These direct consumption sugars are produced by the sulphitation process, in which Mauritius was a pioneer. Great Britain now occupies a position of even greater predominance as a market for the Colony's sugar than even India ever did, and this position has been greatly strengthened by the British preferential tariff. The crop comes on the British market principally from October to March, and during November to January, when the Cuban supply is at a minimum, Mauritius has, as in recent years, been the chief source of supply for this country.

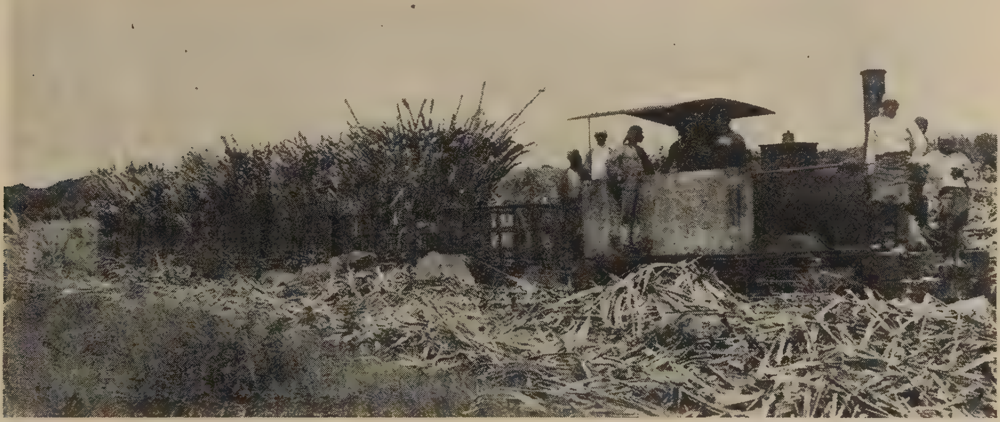

Figure 11.—Transport of cane to factory by plantation railway in Mauritius. (Courtesy of Imperial Institute, London.)

Since the War the export of the chief by-products of the sugar industry, rum and molasses, has been insignificant. Both exports formerly reached high levels, but tariffs and freight difficulties have destroyed their markets. A new possibility has, however, arisen that is of great consequence to the industry, the utilisation of the molasses for the manufacture of power alcohol.

POSITION OF MAURITIUS AS A ONE-CROP COUNTRY

The excessive dependence on one crop, with all the risks of climatic vagaries and disease pertaining thereto, has led to some disquietude. The possibilities, not only of disaster to the crop, but of increased difficulty in marketing the product, are a grave danger to a country depending almost entirely on an imported food supply. The tendency to downward movement in the trade balance of the Colony since 1914 points the moral. The large Indian population has with the stimulus of high prices turned its attention to the money crop and not to food crops, and the result has been a growing import of rice, grain, pulse, and flour. The other chief imports are cottons, artificial fertilisers, machinery, coal, and coke. The position of the sugar industry makes an increasing import of artificial fertilisers and of new machinery a necessity of the future. Exports other than sugar are at present insignificant. The export of the most notable secondary product, aloes fibre, has fallen greatly since the War and experiences great fluctuations, and similar misfortunes have been experienced by the other minor products, such as vanilla, coconut oil, copra, and manioc. The internal market is too limited to give the initial stimulus to a new money crop, while foreign markets suffer from the disadvantage of distance, accentuated by the freight difficulties already experienced, or of having more easily available of highly protected supplies of the various commodities. Capital is scarce enough for the urgent demands of the sugar industry, which must always remain at any rate the chief one, and the amount of capital already invested in the staple industry makes the need for maintaining its capacity, and therefore the area under cane, insistent. The extensive practice of ratoonage makes it difficult to reduce

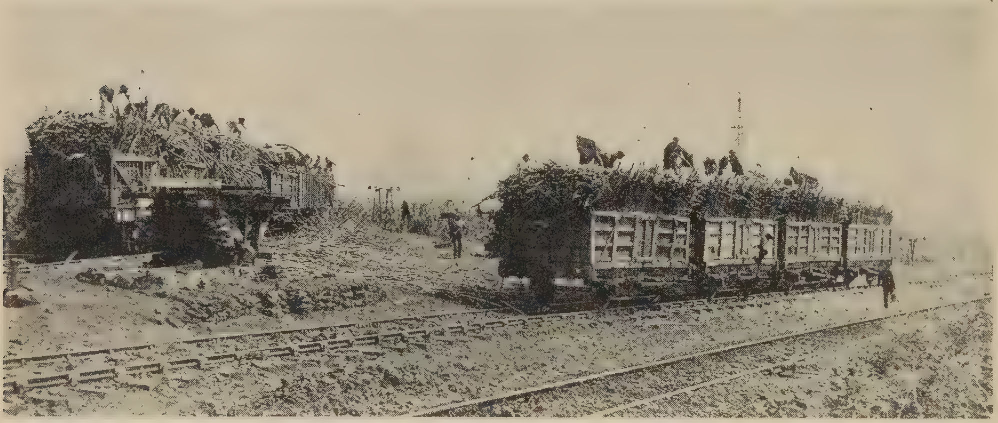

FIGURE 12.—Transport facilities are satisfactory in Mauritius. Loading the cane on railway trucks for transport to the factory. (Courtesy of Miss M. I. Freeland.)

the area under cane, and added to these difficulties is the great problem of labour supply, which, strongly as it is felt in the established industry of the island, would be even more felt in attempting to extend the activities of another industry. As for food crops, the growing of various "ground provisions" such as sweet potatoes is strongly advocated by the Department of Agriculture.

Mauritius conspicuously illustrates the economics of a small one-crop country. Climatic and soil conditions are very favourable to sugar cane and almost the entire area suitable for its cultivation has been occupied by this crop, in some recent years only one-fifth of the total cultivated area being otherwise utilised. Having once embarked on its career of dependence on a dominant money-crop, the Colony finds itself by its location, its financial position, the circumstances of the world's markets, and the economic necessities of the sugar industry itself, forced to persist in this course. In no other country can it be said with more truth that "Sugar is King." In face of this situation, with its accompanying dangers, there is an urgent necessity to stabilise the industry by resolute measures in order to maintain and raise the level of its productive efficiency. The labour shortage by compelling the increased use of mechanical and other methods of raising output per head, has already set the industry in the right direction for progress. While further immigration might alleviate certain difficulties of the present, it would probably aggravate the difficulties of the future, which can be solved only by bringing about more economic production per head. In the long run, therefore, the relatively low rate of increase in the population is for the Colony's good. In Mauritius, as in other parts of the Tropics, the immense importance of bold public health measures in raising general standards is gradually being realised, and the developments that have been initiated in this direction, though slower in effect, promise well for the future. While irrigation schemes and some few necessary improvements in transport facilities will make possible some comparatively slight expansion of the area under cane, the main efforts of the community must be directed to lowering costs of production. The process of "morcellement" that has rapidly extended has certainly added very greatly to the difficulties in the way of improvement, but some recent developments offer hopes of their reduction, and the process contains elements not only of weakness but of strength. Progress towards lowering unit costs demands, besides the overcoming of the usual forces of conservatism, the initial expenditure of a considerable amount of capital. However, the financial position of the Colony has been good so far and, while it is yet possible, the good returns of the past can be made the basis of future development.

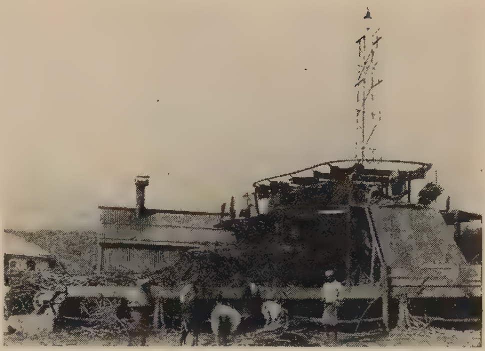

FIGURE 13.—Cane arriving at factory by aerial ropeway in Mauritius. The hilly nature of much of the Mauritius cane land makes this method of transport necessary. (Courtesy of Miss M. I. Freeland.)

AGRICULTURE AND COMMERCE OF UGANDA

Earl C. Case

Geographer, University of Cincinnati

THE Protectorate of Uganda, which occupies 110,000 square miles in the heart of Africa, lies astride the equator (Fig. 1). Despite this fact, its great range of elevation gives it a diversity of climates which vary from near desert to that of exceedingly heavy rainfall, and from the hot debilitating temperatures of the lowlands to perpetual snow and ice on the mountainous uplands. The first reports of perennial snow near the equator seemed so anomalous that the geographers at home believed they were merely the fanciful stories of travelers. Except in the Rowenzori Mountains of the southwest where it is cool, and in the lowlands of the north where it is hot, the temperature is moderate and varies but little throughout the year. Most of the populous areas of Uganda lie at altitudes of 3,000 to 5,000 feet, and although the climate is much more pleasant than in the lowlands, it cannot be considered healthful for Europeans.[1]

The rainfall varies greatly from one section to another (Fig. 2), and as in most equatorial regions is unreliable at best. In the southern part of the Protectorate there are four seasons—two wet and two relatively dry; towards the north, the type of climate changes to summer rains and winter droughts (Fig. 3).

The isolated position of Uganda delayed commercial development of the area until the beginning of the present century, and made it one of the last portions of Africa to feel the beneficial influence of western civilization. Prior to 1900, the only commercial products of this equatorial upland were slaves and ivory, secured, for the most part, by the unscrupulous traders who planted the seeds of suspicion and hatred in the hearts of the natives, and made the problems of true development difficult.

In spite of the handicaps of location, climate, and unpleasant contacts with the early traders, the development of Uganda during the past twenty-five years has gone forward with remarkable rapidity. Natives, who are not yet old, remember when human beings were bartered among man-eating tribes.[2] They have seen slaves captured and sold for a few trinkets to Arab traders who loaded them with ivory and marched them on a dismal journey to the coast, where both they and their cargo were sold at neighboring markets. Today all this is changed: both life and property are relatively secure; the wealth of the natives is increasing rapidly through the export of cotton and other agricultural products, which are worth many times the value of the slaves and ivory of a generation ago. The early imports of beads, trinkets, and a little calico, have been displaced by motor-cars, bicycles, plows, hoes, shovels, millions of yards of cloth, and other products useful in the development of a country. Next to Zanzibar and the Gold Coast, Uganda now leads the continent in the per capita value of export trade.

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[1] Wallis, R. H., *Hand Book of Uganda*, 1920.

[2] Nordmen, Herman, *White and Black in East Africa.* H. F. & G. Witherby, London, 1924.

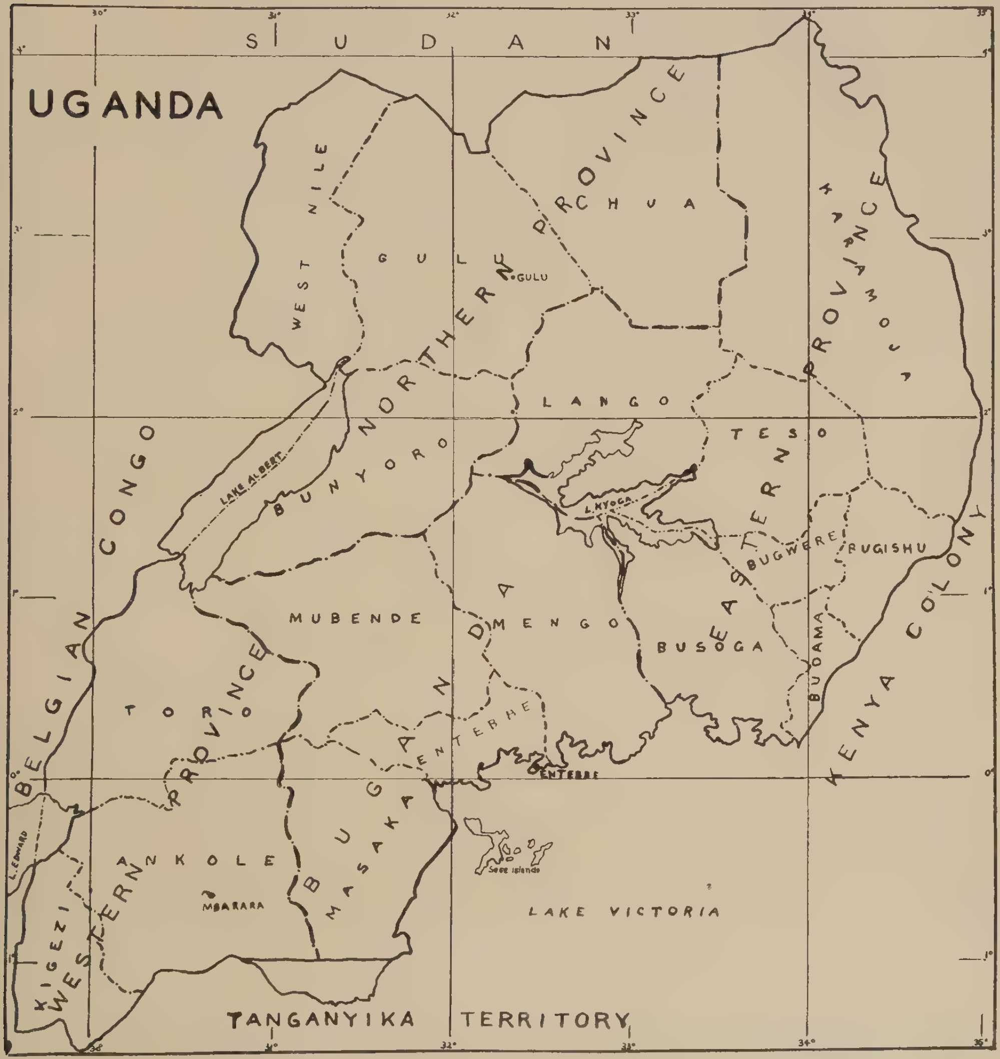
UGANDA
SUDAN
BELGIAN CONGO
KENYA COLONY
TANGANYIKA TERRITORY
NORTHERN PROVINCE
EASTERN PROVINCE
WESTERN PROVINCE
BUGANDA PROVINCE
WEST NILE
GULU
GULU
CHUA
KARAMOJA
LANGO
TESO
BUNYORO
LAKE ALBERT
L. KYOGA
BUGWERE
BUGISHU
BUDAMA
BUSOGA
MENGO
MUBENDE
TORO
ENTEBBE
ENTEBBE
ANKOLE
MBARARA
MASAKA
KIGEZI
L. EDWARD
Sese Islands
LAKE VICTORIA
30°
31°
32°
33°
34°
35°
4°
3°
2°
1°
0°
1°

FIGURE 1.—Place map of Uganda.

EARLY DEVELOPMENT OF SUBSISTENCE FARMING

Agriculture was already well developed within the present bounds of Uganda when the early European explorers arrived. The southern part of Busoga was so singularly rich in food and cattle that it was regarded as the "promised land" by caravans from the east coast. Eastern Teso supported an "enormous density of population" before western ideas had influenced the region. The lower slopes of Mt. Elgon, and mountain spurs stretching far out into the surrounding plains, were continuous fields of bananas, millet, and wimbi. More than 80 per cent of the land in extensive areas was

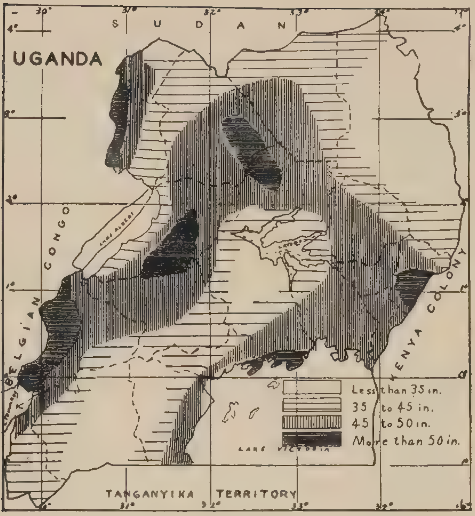

FIGURE 2.—Rainfall map of Uganda.

under cultivation, and only a few green patches of grass had been spared to provide pasture for cattle and goats. The boundaries of all the plots were so clearly and neatly marked that the country side reminded one of the vineyards of Switzerland and southern France.[3]

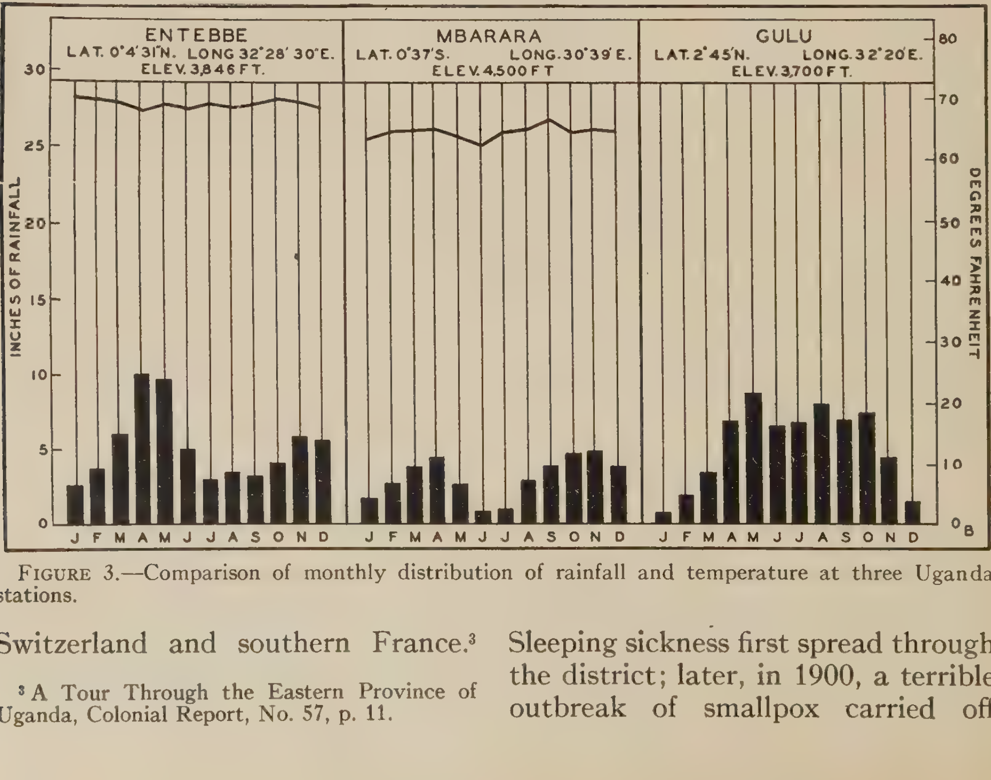

FIGURE 3.—Comparison of monthly distribution of rainfall and temperature at three Uganda stations.

Agriculture was the chief occupation of all tribes except those living within the more arid areas of the southwest and the northeast (Fig. 2), where pastoral activities were dominant.

Not all of Uganda, however, was densely populated. There were large areas of fertile land lying waste then just as there are today—probably the result of pestilence and famine. For example, the Sese Islands in Northern Lake Victoria were once the habitation of hundreds of thousands of people. Today they are dense jungles. Sleeping sickness wrought such devastation among the islanders in 1907 that there was a wholesale removal of those who survived to the mainland. Attempts to repopulate Sese have been made, but the people are unwilling to return to their old homes. Large sections of southern Busoga, which were at one time densely populated, are now waste. Sleeping sickness first spread through the district; later, in 1900, a terrible outbreak of smallpox carried off

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[3] A Tour Through the Eastern Province of Uganda, Colonial Report, No. 57, p. 11.

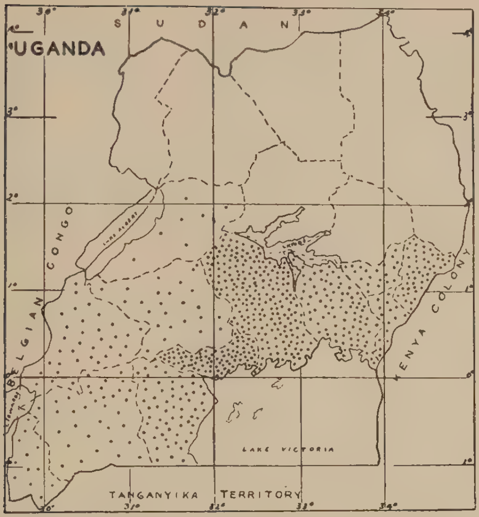

FIGURE 4.—Distribution of plantain culture. Each dot represents 1,000 acres. The dots are uniformly distributed throughout the districts, but relatively little is grown in areas of less than 35 inches of rainfall (see Figure 2).

many thousands; the famine of 1908 completed the devastation so that now the land is bush, inhabited by pigs, leopards, hyenas, and other wild animals.

PRESENT TYPES OF SUBSISTENCE AGRICULTURE

The agriculture of Uganda is rather sharply divided into two types—plantain growing in the southeast and millet production in the north and the extreme southwest (Figs. 4 and 5). In addition, there are two areas—one in the northeast and the other in the southwest—where, because of light and uncertain rainfall, pastoral activities are still important, if not dominant.

Each type of agriculture has its own division of labor. Where plantain is the chief food, agriculture is the work of women. The increasing need for laborers to work in the cotton fields, together with the influence of western ideas, have resulted in more of the work being done by the men. The men help clear the land after which their labors are relatively light.[4] In the millet-growing area men till the soil and harvest the crops, assisted more or less by the women and children; in the pastoral districts, on the other hand, women have little to do. Men care for the cattle and, since the natives wear but scant clothing and live almost exclusively on a milk diet which requires no special preparation, the amount of housework is negligible. As a result, the women have an easy time.

The Plantain Belt

Plantain is the most important subsistence crop of Uganda and ranks second only to millet in the acreage cultivated (Fig. 6). Although a slightly larger acreage is given to millet, the plantain is more productive and yields during the entire year. Within the southeastern part of the Protectorate it is the chief food-crop of the natives, and in

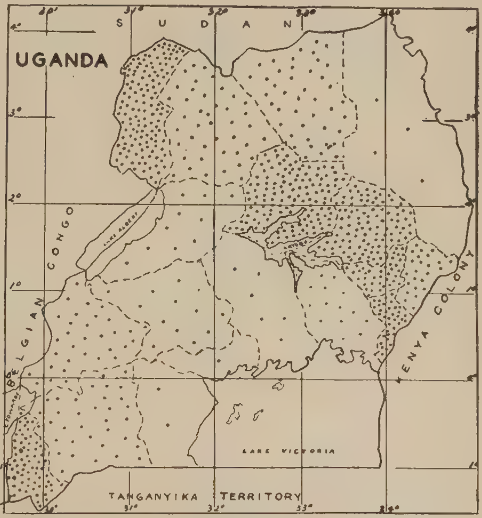

FIGURE 5.—Distribution of millet culture. Each dot represents 1,000 acres.

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[4] Roscoe, John, *The Burganda, Their Customs and Beliefs*, p. 430.

several districts it occupies more than twice as much land as all other food-crops combined. Its dominance was even greater a few years ago when, over extensive areas, it occupied more than 85 per cent of the land cultivated in food-crops.[5] Earlier reports indicate that in certain sections it was grown to the exclusion of all other crops and that thousands of natives were obliged to eat nothing but plantain pulp.

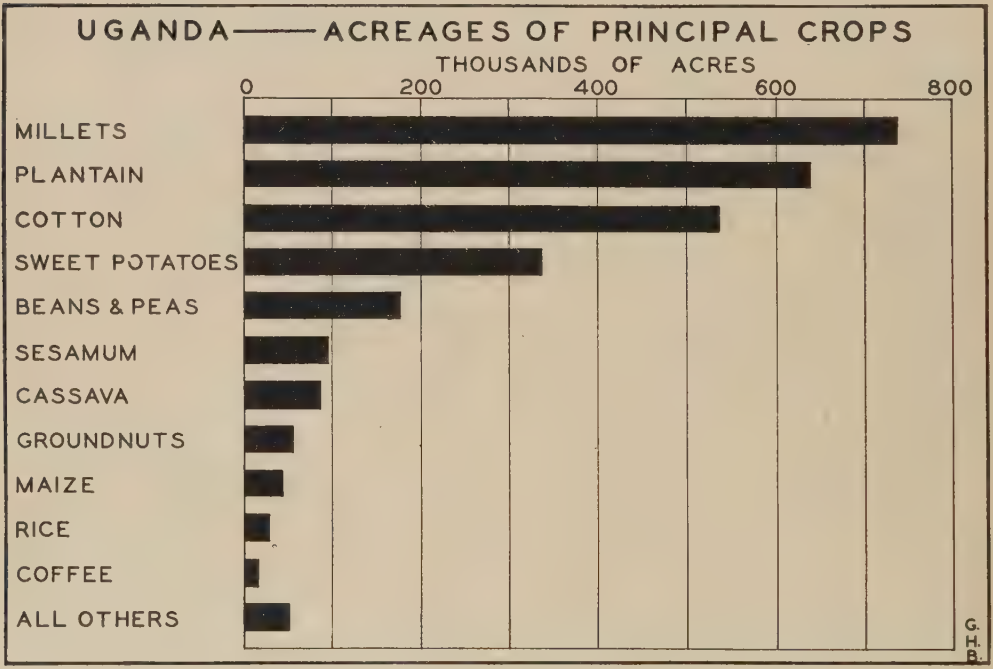

FIGURE 6.—The acreage given to each of the principal crops of Uganda (000 omitted).

During the last few years the cultivation of sweet potatoes, cassava, sesamum, beans, and groundnuts has increased rapidly, but the natives still look to the plantain as the mainstay (Fig. 7).

Where the plantain tree bears well, it affords a reliable food supply throughout the year with the minimum amount of labor. After the land is cleared and the plants are started, they continue to yield fruit year after year. When once a tree begins to grow, it soon makes side-shoots which are well developed by the time the fruit of the parent tree is ripe. Thus, until the soil becomes depleted, the food and beer supply of the family is assured, unless the rains fail or the locusts destroy the crop. During the dry season no care is given to the plantain garden except that of merely cutting the fruit; when the rains come, the weeds must be kept down in order that the crops may thrive.

Since the plantain tree yields during the entire year, the natives make no provision for the future, unless it be to dry a little fruit. As a result, any failure of the crop brings on famine. When the dry season lasts longer than two months, the plantain yield decreases. Fortunately, the roots of the tree, which contain some nourishment, may be eaten by the natives to help tide them over such periods. Yet malnutrition and starvation, combined with pestilence, has practically depopulated large areas from time to time.

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[5] Uganda Protectorate, Ann. Report, Dep't of Agr., Entebbe, 1920, p. 42.

The Cereal Belt

The natives of northern Uganda are even more dependent upon cereals than those of the southeastern part are upon plantain. In Gulu and Chau, millet and sesamum (primarily millet) occupy 96 per cent of the land cultivated in food-crops. In the other districts, sweet potatoes, cassava, beans, and peas are more widely grown, but north of Lake Kyoga, cereals constitute the main food-crops, just as the plantain does in the southeast.

This contrast in agricultural types is usually ascribed to the fact that northern Uganda is populated with grain-eating peoples—the Neolithic groups—whereas, southern Uganda is occupied by plantain-eating peoples—the Bantu groups. The agricultural difference, however, is undoubtedly more closely related to environmental contrasts than to racial prejudices or appetites. In the north, the seasons are quite distinct and the dry period may last for several months, even where the average annual rainfall is heavy. For example, the average precipitation at Gulu is more than 50 inches; yet, in 1924, the rainfall during the five months, November to March inclusive, was only 4.49 inches,[6] resulting in a drought which would have been fatal to plantain trees.

The rainfall of this northern section is also extremely local, and any

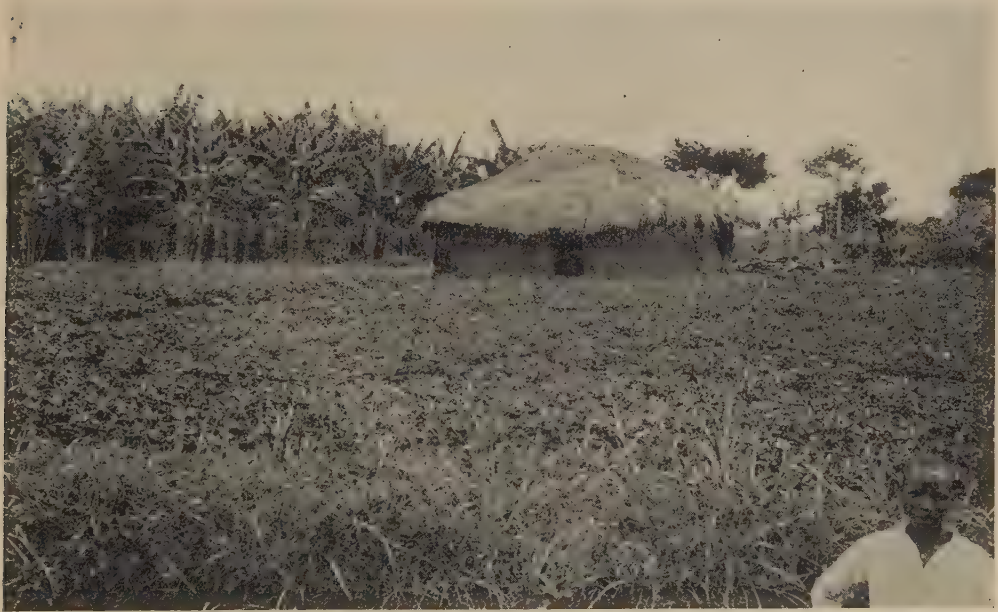

FIGURE 7.—A typical native shamba surrounded by plantain, peas, and sweet potatoes—the three principal food crops of southern Uganda. (Courtesy of L. W. Kephart, Foreign Crops Division, U. S. Dept. of Agric.)

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[6] Uganda Protectorate, Ann. Report, Dep't of Agr. 1924, p. 52.

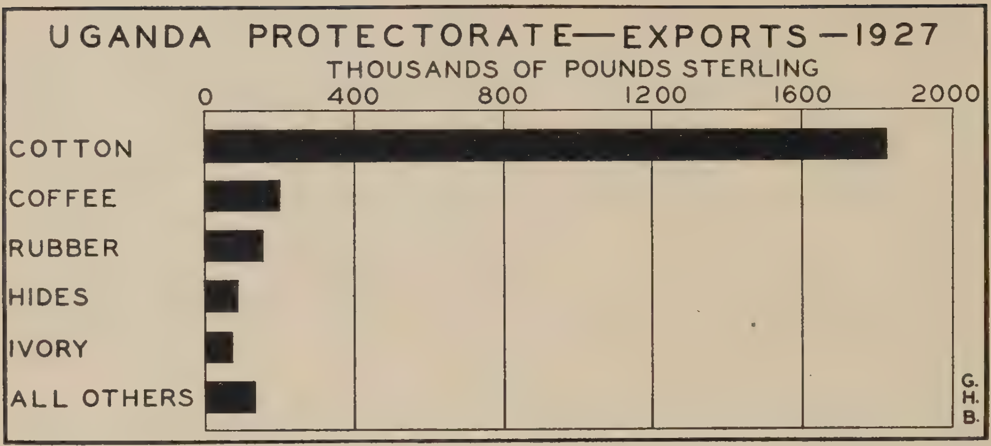

FIGURE 8.—Exports of Uganda Protectorate, 1927, pounds sterling (000 omitted). (Compiled from Uganda Dept. of Agric., Entebbe, 1928, page 51.)

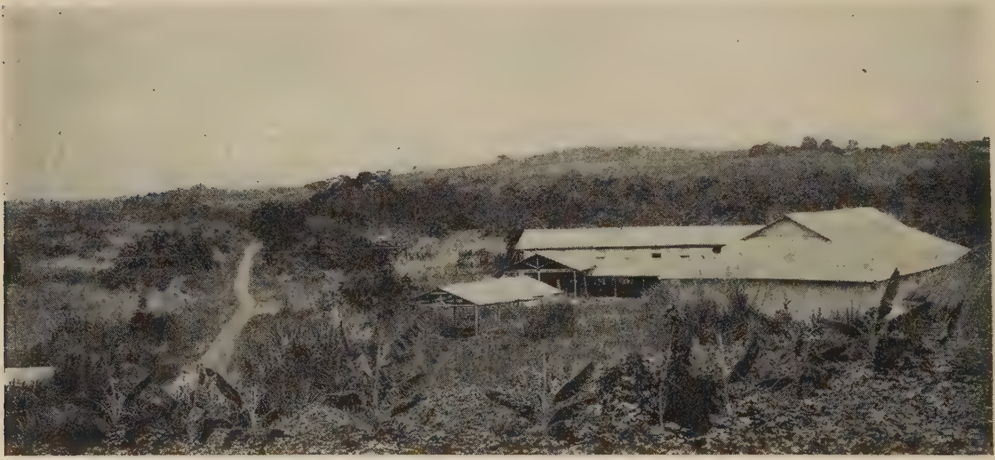

FIGURE 9.—A cotton ginnery and a field of cotton interplanted with plantain. Most of the cotton is grown in quarter-acre or half-acre plots. (Courtesy of L. W. Kephart, Foreign Crops Division, U. S. Dept. of Agric.)

given plot of ground may be missed by showers for months at a time. This fact is so well recognized that it is the custom of the natives to plant their crops in little plots widely scattered, in order that if some plots suffer from drought others may be more fortunate. In places sandy soil adds to the droughty character of the *cereal belt*, making it suitable only for those crops which mature quickly.

Although the northern section is poorly suited to plantain, it produces good crops of millet when the season is favorable. Failures, however, are frequent and during years of abundance large reserves of grain are stored for years of dearth. Yet, the problem of keeping the grain for any protracted period of time in this hot climate is not a simple one. Millet seed, which can be kept almost indefinitely in our own semi-arid

West, is soon attacked in Uganda by beetles and weevils, making it difficult to save even with our modern knowledge of science.

The Pastoral Belt

There are two large districts in Uganda—Ankole and Karamoja—where the rainfall is light and unreliable, and as a result, they are primarily given to pastoral industries. In Ankole the governing class is composed of a people who are entirely pastoral and look upon agriculture with contempt. Many of these cowmen live entirely on a milk diet and it is of interest to know that during the war they were tested in the carrier corps and found to be capable of hard and sustained work.

In the pastoral areas, cows are the highest form of currency and all prices are regulated by their value. Wives are purchased by the payment of one or more cows, and the value of sheep and goats is fixed by the number a man will exchange for a cow.

The lower classes cultivate fields of millet and bananas, which they use as food and for the manufacture of beer, both for themselves and the upper classes.

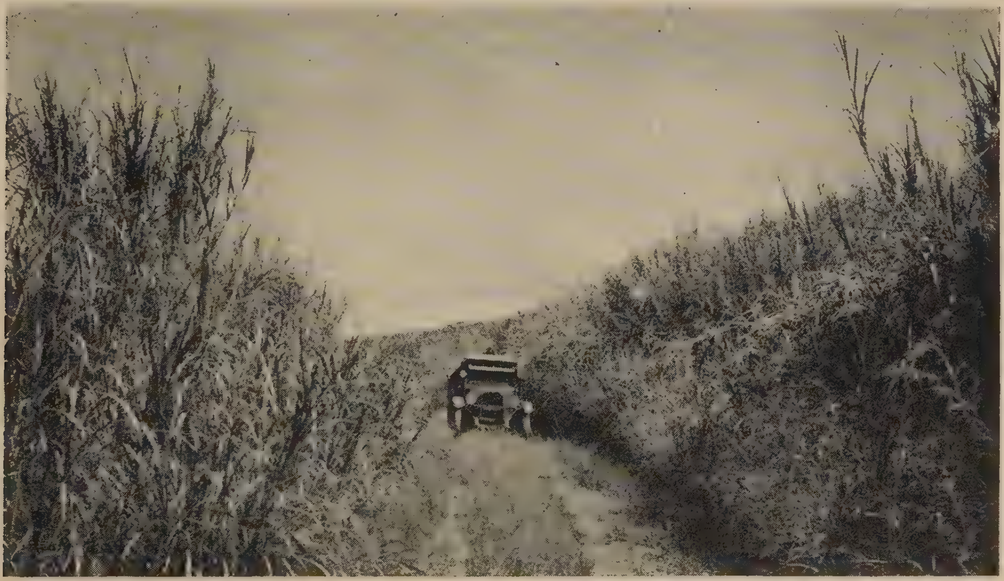

FIGURE 10.—Elephant grass—one of the most common types of native vegetation. It is no easy task to clear this ground and prepare it for planting. (Courtesy of L. W. Kephart, Foreign Crops Division, U. S. Dept. of Agric.)

COMMERCIAL CROPS

The construction of the Uganda Railway afforded opportunity for developments within the Protectorate which have been almost revolutionary in proportions. Formerly, the tribes were primarily subsistence farmers, consuming all they produced. As previously stated, the only exports were slaves and ivory for which the natives received little of value in return. The completion of the railway from Uganda to the coast in 1901 encouraged the promotion of other commercial enterprises. The rapidity with which this development has taken place is indicated by the fact that the exports increased from practically nil in 1905 to more than 25 million dollars twenty years later. More significant, however, than the development of this export trade has been the far-reaching changes which it has brought about in the economic and social status of the natives.

COTTON, THE MAJOR COMMERCIAL CROP

Cotton has grown wild in Uganda for centuries, but apparently the natives had no idea of its potential value until its cultivation was introduced by European missionaries in 1900.[7] Since then the production has increased with such remarkable rapidity that 20 per cent of the cultivated land is now given to this crop. During the last few years cotton has become of such great economic importance that it has been called "the life blood of Uganda," and at present represents more than 90 per cent of the total exports of the Protectorate (Fig. 8).

The crop is grown entirely on native plantations and by native labor. Its cultivation has spread to every district except Karamoja, in the northeast, where the rainfall is too light or uncertain for cotton culture, and West Nile, Kigizi, and Toro, all poorly situated with respect to improved transportation facilities. Moreover, much of West Nile and Toro are low, swampy, hot, and unhealthful.

The usual method of cultivation is to clear about a quarter-acre of grass, weeds, and trees after which the land is merely dug over lightly with a hoe. There are no large plantations of cotton in Uganda. Most of it is grown in quarter-acre or half-acre plots, and frequently is interplanted with other crops (Fig. 9). Plowing schools have been introduced, but less than three thousand plows were in use in 1927.[8] Several difficulties have prevented a rapid increase in the use of machinery: soil choked with the roots of elephant grass and papyrus, two of the most common types of native vegetation, is difficult to turn with a plow (Figs. 10 and 11); rinderpest has preyed upon the oxen, making many of them unfit for work; and plows are bought by communities or chiefs, as individual farmers do not cultivate fields large enough to encourage the purchase of such expensive machinery.

In a few places tractors have been used in breaking large tracts of land, which are then subdivided into half-acre plots and let out to the natives for planting and cultivating. Most of the work, however, is still done with the hoe, matchet, ax, and spade. In 1926 and 1927, slightly less than a million of these simple tools were imported—almost enough to supply every able-bodied laborer in the Protectorate.[9]

The amount of human effort required to produce and market cotton in Uganda would be considered appalling in the American Cotton Belt. After the native has cleared the land with an ax and matchet, and has broken the ground and cultivated the crop with spade and hoe, he must then carry his crop on his head to the ginnery, often many miles away. Human portage is still the common

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[7] Report on the Introduction and Establishment of the Cotton Industry in the Uganda Protectorate, Colonial Report No. 62, 1909.

[8] Uganda Protectorate, Ann. Report, Dep't of Agr. 1927, p. 16.

[9] Annual Trade Report of Kenya and Uganda, Nairobi, 1928, p. 30.

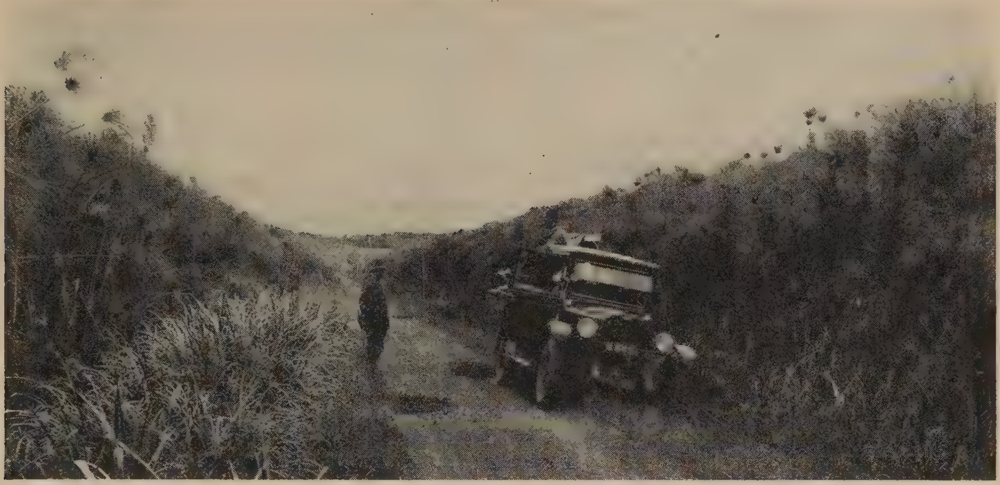

FIGURE 11.—Papyrus—one of the most common types of native vegetation found in the poorly drained areas. (Courtesy of L. W. Kephart, Foreign Crops Division, U. S. Dept. of Agric.)

method of conveying the seed-cotton to the ginneries, although during the last few years, light trucks are being introduced for this purpose.

After the cotton passes into the hands of the merchants, much of the work is done by efficient machinery; modern ginneries separate the lent from the seed, and trucks made in Europe and America transport the fiber to railroad points and to lake ports for shipment to the textile mills of industrial countries.

Cotton Culture and Social Conditions

Costly as this cotton seems, in human effort, its cultivation has brought about changes in social conditions which are little less than revolutionary in character. As a result of its production, both peasants and landlords have become comparatively wealthy. While the standards of living are still extremely low, compared with those of European peoples, they are incomparably better than they were a few decades ago, when because of famine, pestilence, tribal wars, and slave raids, neither life nor property were secure.

The old round-thatched hut with but an aperture for a door, is giving way to a square house with windows, doors, and chimneys (Fig. 12). Many of these homes are surrounded by gardens, lawns, and reed fences. European cooking utensils and knives and forks are being introduced, while European crockery is displacing the old native calabash. Nudity is disappearing and the sale of cloth to the natives is tremendous. In 1927, more than 16 million yards of cotton goods and 50,000 dollars' worth of silks were imported.[10] The sale of boots and shoes, underwear, women's dresses, and umbrellas, while not large, is increasing.

In 1900, there were no roads in Uganda, and the natives had little or no freedom in moving about. Today the Protectorate has thousands of miles of good highways which reach into almost every district, and the natives move about freely, going to the most remote part of the Protectorate to find employment. They have purchased 10,000 bicycles and hundreds of motorcycles and motorcars in a single year.[11] While one cannot attribute all of these benefits to the production of cotton, still it is the greatest single motivating force in the economic development.

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[10] Annual Trade Report of Kenya and Uganda, Nairobi, 1928, p. 30.

This increase in wealth has had also its dark side. The natives have not yet learned the art of saving, and to many of them money is simply a means of securing immediate pleasure. Drinking, not only of native beer but also of European liquor, has increased greatly. This has led to more frequent indulgence in drunkenness, crime, and gambling, as is shown by the fact that the number of citations for these offenses have been mounting rapidly during the last few years.

COFFEE AND RUBBER CULTURE

Despite the rapid economic development that has taken place in Uganda, the prosperity of the natives has proven to be somewhat unstable. This is a condition which might be expected in a region depending almost wholly on a single money crop. Good yields and high prices result in prosperity, whereas poor crops or low prices bring about financial depressions and discontentment. At times the fluctuations are sudden and violent, as may be seen by the fact that in 1921 the value of the cotton export was less than one-third that of the previous year despite the fact that production had increased more than 50 per cent.

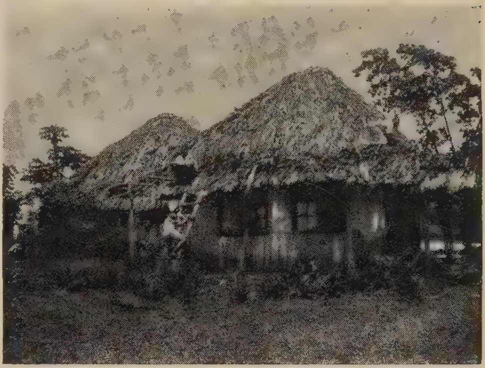

FIGURE 12.—Many of the houses now have windows and some have chimneys and are surrounded with lawns and hedge fences (compare with Figure 7). (Courtesy of L. W. Kephart, Foreign Crops Division, U. S. Dept. of Agric.)

It is extremely difficult for the natives, not acquainted with the laws of trade, to understand these gyrations in prices. The result has been discontentment and hard times when values are low. The natives are prone to place the blame for these conditions upon the English traders, thereby endangering the good will which exists between the Protectorate and the Mother Country.

In order to overcome this danger, the Department of Agriculture has attempted to induce the natives to diversify their cash crops. The department has especially urged the production of coffee, and in 1924 it issued 140,000 Robusta coffee plants to the natives of southeastern Uganda.[12] Yet, the industry has not prospered. The natives prefer to grow a crop which gives more immediate returns. It requires years for coffee and rubber trees to mature, whereas cotton is ready for harvest within a few months after it is planted. Moreover, coffee and rubber trees are attacked by many insects and require more careful attention than the natives are willing to give them.

Plantation Agriculture of Europeans

For a time the production of coffee and rubber increased rapidly on the plantations of European settlers, but during the last decade both acreage and production have fallen off and rubber is produced only when prices are high.

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[11] *Ibid.*

[12] Uganda Protectorate, Ann. Report, Dep't of Agr. 1924, p. 7.

It has been proven that Arabic coffee, the type grown most abundantly in Uganda, does not thrive at altitudes of less than 4,500 feet. As a result, many of the trees planted at lower levels have been cut down and, since there is but relatively little land above this area which is of easy access, the opportunity for expansion of Arabic-coffee culture does not seem bright. Robusta coffee does well at lower elevations, but European planters are but little interested in lowland development.

European settlers developed large rubber plantations in southeastern Uganda, but for some years the low price of rubber has rendered tapping unprofitable. During the years when rubber prices were low, these plantations were entirely abandoned and permitted to grow up in weeds and worthless trees. With the increase in rubber prices many of these estates, which were derelict, were brought back into cultivation.

THE OUTLOOK

During the past generation the natives of Uganda have made more progress than the peoples of Europe made in a thousand years when they were just emerging from barbarism. This rapid development has been due, of course, to the fact that the natives of Uganda have had civilization thrust upon them. Yet, this is not the first time that peoples from the temperate zone have stimulated progress within this area. During the last few thousand years there have been many invasions from the north, and the inflow of much northern and Asiatic blood; but once any given wave of immigration had been completed, there was a tendency towards retrogression again. Sir Harry Johnston has said that it is only by invasion from the north that the mid-African is kept from reverting to a more primitive state. Thus, in the light of history, one may ask if the present progress will continue.

The present attempt at development is fundamentally different from those of the past. Formerly, the invaders changed the environment but little: the area remained isolated; there was no scientific waging of war against malaria, sleeping sickness, dysentery, rinderpest, and other diseases of man and beast; but little headway was made in preventing the re-occurring famines as is now being done by diversifying crops, importing drought-resisting plants and improving transportation facilities. Moreover, the invaders adopted the native foods which, for the most part, are ill-suited to the development of a hardy people. Neither the plantain nor the cereal diet can be considered a balanced ration. In other words, the invaders accepted the environment as they found it and were unable to make progress under such conditions.

The present industrial development is closely related to the success in overcoming isolation, disease, and famine, and in improving the diet of the natives. That is, it is based on the improvement of the native and his environment, and not merely upon the injection of new blood and of a few more vigorous people.

The rapidity of development will not only depend upon the success in overcoming adverse environmental conditions, but also upon the degree of success in instilling in the natives a strong desire for the better things of civilization.

LOWER RIO GRANDE VALLEY OF TEXAS

William T. Chambers

Geographer, Stephen F. Austin State Teachers College

THE American part of the Rio Grande delta and some adjoining land in the Gulf coastal plain is a prosperous and progressive irrigation and dry-farming district. The inhabitants, numbering about 150,000, live in small, thriving cities and upon farms made by the subdivision of ranches, the removal of thorn-bush vegetation, and the installation of irrigation facilities. The production and marketing of early vegetables, citrus fruits, and cotton gives such abounding prosperity that immigration is attracted from other sections of the United States; and the population has increased rapidly during the last two decades. Modern homes, business houses, school and church buildings, and recently constructed highways and railroads impart a vigorous, progressive aspect to urban and rural landscapes, while areas occupied by mesquite, chaparral, prickly pear, and prairie grasses, in many cases used as cattle range, give a striking conception of the recent past of the region.

The Lower Rio Grande Valley is becoming an important commercial producer of early vegetables and citrus fruits. Subtropical location and position beside the warm waters of the Gulf of Mexico give the advantages of mild, almost frost-free climate, so essential to these industries. The average annual rainfall varies from 26 to 17 inches according to distance from the Gulf, and is supplemented by irrigation with water from the Rio Grande so that these crops grow abundantly on the fertile plain. Since the area is in the United States and is efficiently served by the Missouri Pacific and Southern Pacific railroad lines, it has the additional advantage of excellent access to the enormous American market for early vegetables and citrus fruits. These factors enable such effective competition with producing areas in California and Florida that carlot shipments of vegetables rose from less than 2,000 in 1912 to more than 17,600 in 1928; and, in the latter year, 1,183 cars of citrus fruits moved from the Valley.

EARLY VEGETABLE CROPS

Early vegetable crops constitute the chief source of regional income at the present time. They are grown during the mild winter and spring months, and are marketed early enough to secure high prices as luxury commodities while fresh vegetables are relatively scarce. When competing districts located north of the Gulf of Mexico begin shipping a given vegetable, the price it commands in the North and East tends to become so low that Valley producers are unable to compete successfully in those distant markets. The intensive character, high productivity, and large return per unit of land employed commend vegetable crops to farmers in this region where land is expensive and water must be purchased for irrigation. They are more profitable than such staple crops as cotton and corn on the lighter, well-drained soils, and have the great advantage of yielding an income a few weeks or months after planting. Therefore, many persons who plan to become citrus growers secure an income by the production of vegetables while their citrus plantings are below bearing age.

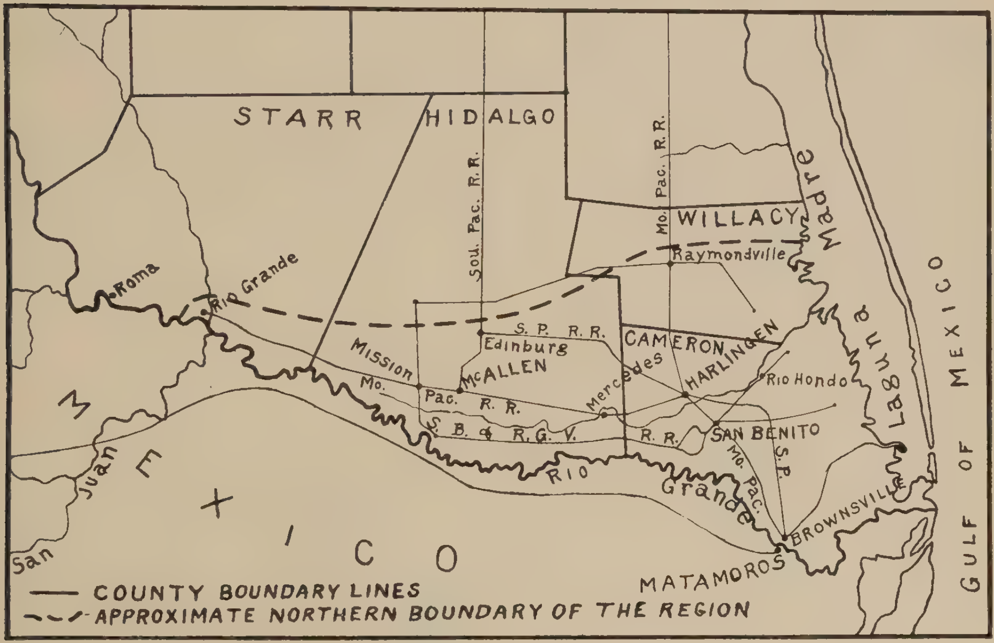
STARR
HIDALGO
WILLACY
CAMERON
Sou. Pac. R.R.
Mo. Pac. R.R.
Raymondville
Madre
Laguna
Roma
Rio Grande
Mission
S. P. R. R.
Edinburg
McALLEN
Mercedes
HARLINGEN
Rio Hondo
Mo. Pac. R. R.
S. B. & R. G. V. R. R.
SAN BENITO
S. P.
Mo. Pac.
Rio Grande
BROWNSVILLE
MATAMOROS
San Juan
MEXICO
GULF OF MEXICO
COUNTY BOUNDARY LINES
APPROXIMATE NORTHERN BOUNDARY OF THE REGION

Figure 1.—Map of Lower Rio Grande Valley and adjoining areas.

Cabbage is the great vegetable crop of the Lower Rio Grande Valley. Shipments have averaged almost 4,000 carlots a year since 1920, and in 1928 they numbered 5,915 or 33 per cent of the total vegetable movement from the region. Ability of the crop to escape injury during the occasional cold spells of winter, and the large capacity of the market commend it to growers. Cabbage is easy to harvest, and is so firm and durable that most of it is shipped in refrigerator cars without crating. These factors facilitate economical marketing, and enable distribution to ultimate consumers at prices much lower than those of most early vegetables, thus enlarging the buying capacity of accessible markets. Preference for fresh cabbage over cold storage stock enables the Valley crop to enter markets in the North and East during the winter and early spring. Florida offers competition throughout the season, and the crop of Alabama and Mississippi is on the market during May; but Texas has decided leadership in the early commercial crop, and most of the production is in the Lower Rio Grande Valley. The plants are set from seed beds into fields about the first of September. They are watered and cultivated at intervals until ready for harvesting in February, March, or April; when they are gathered, hauled to shipping sheds, and sold to buyers. A large tonnage of inferior cabbage is left in the field or rejected at shipping stations, especially late in the season and when prices are low.

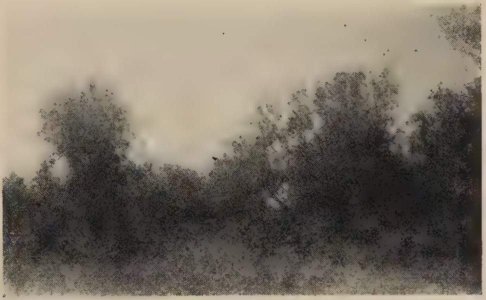

FIGURE 2.—Until recently the Lower Rio Grande Valley was a land of mesquite bush, prickly pear, and prairie grass; and parts of it are still occupied by this sort of vegetation.

There is also a large commercial crop of early Irish potatoes. Mild winter temperatures, fertile silty loam soils, and an abundance of water for irrigation enable most growers to get their crops on the market during April. The output must compete with the cold storage stock of northern and eastern states and with the fresh crop of Florida. That this competition is being successfully met is indicated by the increase of carlot shipments from 175 in 1920 to 1,011 in 1925 and 1,567 in 1928. Chicago, St. Louis, and Kansas City are the largest buyers because of the great capacity of their respective trade territories and their greater proximity to the Lower Rio Grande Valley than to producing centers in Florida. Production is largely confined to areas of silty clay loam having good underdrainage which are located in Cameron County near Brownsville, San Benito, and Los Fresnos. Rapid increase of production reflects the strong demand and satisfactory prices producers have received for the crop. They are being educated in the proper grading and standardization of their pack by the Rio Grande Potato Growers Association, organized in 1925.

Tomatoes have become one of the leading early vegetable crops of the Valley in recent years. Only 185 carlots were marketed in 1920, but shipments increased to 342 cars in 1925 and in 1928 they amounted to 1,407 carlots. This crop requires more labor and is more perishable than potatoes; but it brings higher prices per unit of output, and yields abundantly. The heaviest production is in Cameron County, particularly about San Benito, Harlingen, and Brownsville; but large shipments are also made at Mercedes, Donna, and other centers in Hidalgo County. The crop is usually marketed during May and June, the first shipments being about two weeks earlier than those from competing areas located in eastern Texas and Mississippi. A small acreage is planted in the autumn for harvest during December. Tomatoes picked just before they begin to turn pink are wrapped in paper, crated, and shipped in refrigerator cars without icing as "greenwraps"; but much of the crop is marketed as "pinks" and requires refrigeration.

FIGURE 3.—Highly developed area near Harlingen showing palm-lined concrete highway with citrus grove in the background.

Several other vegetables are grown on a commercial scale in the Lower Rio Grande Valley. Carrots, beets, string beans, and green corn are especially important. All these

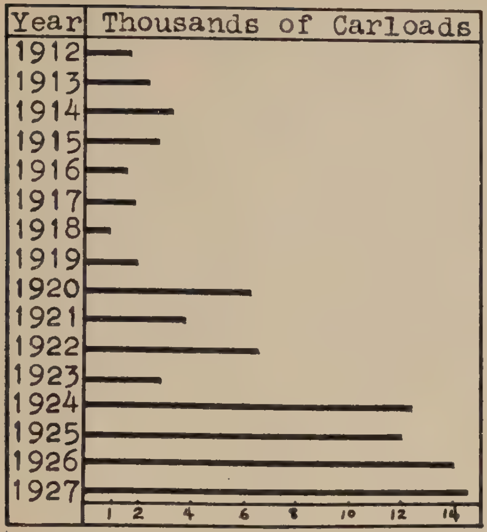

Figure 4.—Increase of carlot shipments of vegetables from the Lower Rio Grande Valley. (Data from Figure 1, Bul. 378, Texas Agric. Exp. Station.)

products, except carrots, are so perishable they do not meet competition from storage stock. Carlot shipments are confined to rather large cities, small centers having such limited capacity for these vegetables that the local dealers buy in smaller quantity. Many cars of carrots, for example, are taken by dealers in New York, Chicago, and several other northern and eastern cities; but none of the cities in Texas ordinarily buy in such large quantity. Hundreds of cars of beets and carrots packed "half and half" are shipped from the Valley, relatively small centers being able to absorb them in that quantity. Lettuce, watermelons, and onions are produced, but these crops are less important than in earlier years. Acreage is also devoted to the growth of rutabagas, turnips, spinach, asparagus, cauliflower, squash, green peas, eggplants, and some other vegetables. Quantities of all these crops are shipped in "mixed" carlots and by express.

Mixed carlot service has greatly facilitated the expansion of accessible markets for early vegetable crops of the Valley. Shippers offer to pack and consign cars containing three or more sorts of vegetables in any proportion specified by buyers. They assemble them from producers by truck, load them in refrigerator cars according to orders, and ship them promptly to patrons. This enables relatively small dealers to order the quantity and variety of available vegetables their market territories will absorb, gives independence of the great markets, assures receipt of vegetables while they are still fresh, and enables their sale at prices lower than would be possible if purchases were made in central markets or were shipped direct in small consignments from producing areas. Thus, mixed carlot service improves the quality and lowers the prices of early vegetables in hundreds of small cities and towns, and stimulates material expansion of the capacity of their respective market territories. These considerations account for the increase of Valley mixed car shipments from 343 cars in 1920 to 3,891 cars in 1925 and to 6,632 cars in 1928. They also give the region a distinct marketing advantage over those competing areas which produce only one or a few sorts of early vegetables on a commercial scale.

Citrus Fruit Industry

The Lower Rio Grande Valley is about as well suited to citriculture as areas in California and Florida which are now engaged in the industry. Location beside the warm waters of the Gulf of Mexico and in a more southerly latitude than Los Angeles or Tampa gives the region a mild subtropical climate. Records of the United States Weather Bureau in-

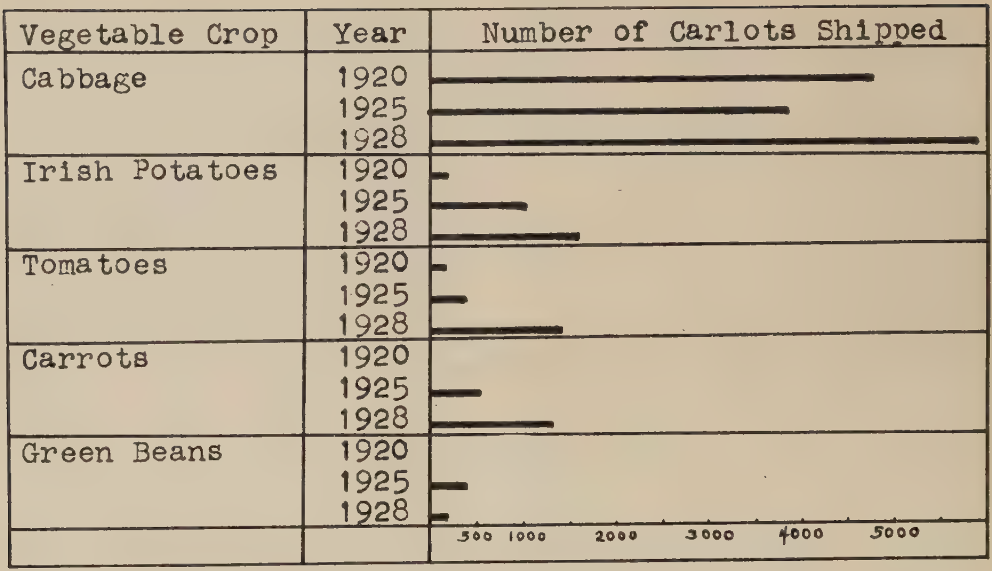

FIGURE 5.—Valley shipments of leading vegetable crops for selected years.

dicate that freezing temperatures occur considerably less frequently at Brownsville than at Redlands, California, or Eustis, Florida, cities located in citrus growing sections of those states. Although Brownsville has fewest frosts per year and there are fewer protracted cold spells than at Redlands, its absolute minimum record of 12° F. is lower than that of Redlands (18° F.) or Eustis (16° F.).[1] However, this is not considered a serious detriment to the industry. Years of practical experience indicate that there are few nights during the winter in which low temperatures necessitate the heating of citrus groves in the Valley, and no artificial heating is required during some years. It seems that the frost hazard in the Lower Rio Grande Valley is approximately equal that of proven citrus-producing areas in California and Florida with which it must compete in the American market.

The competitive position of the Valley is equally strong in some other respects. The alluvial soils and the Rio Grande delta, derived from relatively unleached materials in all parts of its large drainage basin, are doubtless richer in plant foods than the more stony soils of piedmont alluvial plains in southern California or the sandy coastal plain soils of Florida. Location of the Valley at the south-central extremity of the United States gives the advantages of cheaper and quicker service to markets in the western part of the Mississippi drainage basin than competing areas; and, although the area is farther from markets in the Northeastern States than Florida, it is much nearer to them than is California. Moreover, the water supply of the delta is sufficiently large to enable much expansion of citriculture without restriction of other industries. The average annual rainfall varies from 26.36 inches at Brownsville to 17.34 inches at Rio Grande City on the western margin of the region. This enables citrus production by dry-farming methods; but practically all commercial plantings are irrigated because it hastens

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[1] See Figure 7.

FIGURE 6.—Carrots and beets at a shipping shed. (Courtesy of Harlingen Chamber of Commerce.)

development of the trees, increases their productive power, and fertilizes the land by the addition of silt. The quantity of water in the Rio Grande is limited, and its utilization must be shared with Mexico; but the average annual run-off at Brownsville, amounting to 4,320,000 acre feet, is large enough to enable much expansion of the irrigated acreage.

Citrus fruits seem destined to become the chief money crop of the Valley. Commercial plantings were first made in 1907, and interest in the industry has grown steadily, although it was hindered at the outset by scarcity of good nursery stock, a general lack of experience among citrus growers, and uncertainty as to the relative adaptability of different varieties to local soil and of climatic conditions. Courage born of success and knowledge gained by experience in production have increased with the passing years, plantings have expanded enormously, and citrus production has become an absorbing center of interest although the output is still relatively small and the great majority of trees are below bearing age.

The census of 1920 showed that there were 135,153 grapefruit and orange trees in Texas, but plantings have increased rapidly since then. The number of trees was estimated at 1,843,000 in 1925, and it is claimed that there will be 4,000,000 in the Valley by 1930. The increase of Valley citrus shipments from 451 carlots in 1926 to 1,193 carlots in 1928 indicates rapid growth of productive power as increasing numbers of trees attain bearing age. If the present rate of expansion continues, the Lower Rio Grande Valley will soon become a significant competitor of California and Florida in the American citrus fruit industry.

Grapefruit is the dominant citrus crop of the region. It is estimated that from two-thirds to three-fourths of all the trees are of this variety, and most of the remainder are orange. Definite specialization in the production of grapefruit is also indicated by the shipment of 1,024 carlots of that variety in 1928 as compared with 35 carlots of oranges and 124 carlots designated as mixed citrus fruits. This specialization in grapefruit culture is due to the preference given to Texas fruits in the American market. It is said that grapefruit grown in the Lower Rio Grande Valley contain more juice

Average Annual Frequency of:	Name of Stations		
	Redlands	Eustis, Fla.	Brownsville
Spells of freezing weather	6.5	3.4	2.0
Days having freezing temperatures	12.9	5.0	3.5
Days having temperatures of 25° or below	9/17	28/32	21/29
Days having temperatures of 20° or below	2/17	6/32	4/29
Absolute Minimum Temperature	18°	16°	12°
Length of Record in Years	17	32	29

FIGURE 7.—Frequency and severity of freezing temperatures at stations in citrus-producing areas in California, Florida, and Texas.

FIGURE 8.—Rural home in a citrus grove near San Juan.

and are larger, sweeter, and superior in flavor to those produced in California and Florida. These unusual qualities are attributed to superior adaptability of Valley soils to the industry.

Interest in the culture of oranges is increasing, and there is some production of other citrus fruits. Carlot shipments of oranges increased from 6 in 1926 to 17 in 1927 and 35 in 1928. The movement will increase as new groves come into production and as bearing trees grow larger; but oranges will be unable to compete successfully with grapefruit for the attention of Valley citrus growers until varieties better suited to local conditions are secured. Although the Texas orange is quite juicy, its flavor is considered inferior to that of fruits produced in California and Florida; and this handicaps the marketing process and reduces the profits of growers. Lemons, tangerines, and kumquats are grown, but the output is too small to be of commercial significance.

THE COTTON CROP

Cotton is an important field crop in the Lower Rio Grande Valley. It is grown by dry-farming methods in unirrigated areas, and proves a profitable crop on irrigated land in most years. The output increased very rapidly after 1916 as shown in Figure 11 until it amounted to 167,086 bales in 1926. The enormous American crop of that year caused prices to reach such low levels that there was a violent constriction of production in the Valley. Rather heavy, low-lying clay and loam soils, unsuited for the growth of early vegetables and citrus fruits, are used in production. The staple ordinarily brings rather high prices for it is of good quality and comes on the market earlier than the enormous crop of the "Cotton Belt." As in other cotton-producing areas of the South, cottonseed oil is extracted from the seeds; and the cake, meal, and hulls are used as livestock feeds, fertilizer, and articles of commerce.

FIGURE 9.—Gathering grapefruit near Harlingen. (Courtesy of Harlingen Chamber of Commerce.)

THE RANCHING INDUSTRY

There is also a remnant of the ranching industry which was the basic occupation of the population as late as 1904. Since that time railroads have been extended into the area, settlers have been attracted, ranches have been divided into farms, and commercial producers of early vegetables, citrus fruits, and cotton have occupied much of the best land. Areas unsuited to these relatively intensive uses have been avoided by agricultural settlers and are chiefly useful for cattle raising. Extensive areas in the northern part of the region, coastal flats bordering the Gulf of Mexico, and marshy depressions between intermittent distributaries of the Rio Grande are of this sort. Much of this land will be cleared and drained ultimately for use in farming; but at present it is occupied by native grasses and thorny shrubs, and is suitable only for use as pasture. Some of this land is held for speculative purposes, but part of it is stocked and supports a small cattle raising industry.

FIGURE 10.—Young orange tree in the Lower Rio Grande Valley. (Courtesy of Harlingen Chamber of Commerce.)

REGIONAL PROBLEMS

A comprehensive flood control project has been constructed to give protection from the Rio Grande. Elephant Butte Dam regulates water from the upper part of the drainage basin; but the erratic flow poured into the middle and lower courses of the river by the Conchos, Pecos, Salado, and other tributaries causes occasional flood in the delta. Here the relatively low banks and small gradient of the channel, together with heavy sedimentation due to decreasing velocity of current, conspire to increase flood frequency and intensity. As settlement of the Valley progressed, flood control became an increasingly pressing problem. At length the legislature of Texas remitted most of the state taxes in Hidalgo, Cameron, and Willacy counties for a period of twenty-five years each; and funds thus created, supplemented by local bond issues, were applied to the construction of flood control works. The project completed in 1928 consists of levees along the banks of the Rio Grande[2] and floodways bordered by levees through which flood waters collected west of Mission flow to the shore of Laguna Madre. The main floodway follows the course of Arroyo Colorado; and smaller intermittent distributaries of the Rio Grande, known locally as resacas, carry off much flood water.

The conservation and more efficient use of water are problems now pressing for solution. The Rio Grande, like most streams having semi-arid and arid drainage basins, has an erratic flow. The minimum annual run-off recorded at Brownsville is approximately a third of the maximum of 9,000,000 acre feet; and, although floods occur frequently, there are times when practically all the flow is used in irrigation. An agreement should be concluded with Mexico providing for the division of the water supply, the construction of reservoirs in which to impound flood waters, and their use in irrigation on each side of the international boundary. The average annual flow of 4,480,000 acre-feet at Roma probably could be made to

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[2] Mexico constructed the levees on the southern bank of the river.

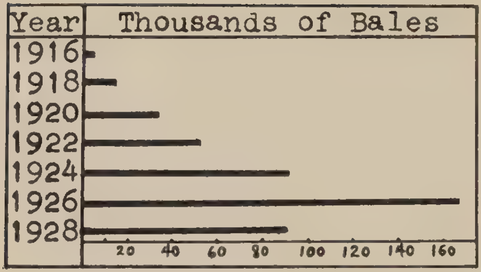

FIGURE 11.—Cotton ginned in Valley counties during selected years.

irrigate 2,000,000 acres as compared with 300,000 acres now said to be included in irrigation projects. The use of concrete-lined canals and underground distribution mains would save large quantities of water now lost by seepage to the injury of poorly drained low-lying lands. There is considerable agitation favoring these several improvements, and the adoption of a unified gravity system of irrigation to replace the many independent pumping systems now operating.

Drainage of low land to prevent the rise of the water table and alkali accumulation is also a problem in the Valley. The land slopes gently away from the Rio Grande and its flood channels (intermittent distributaries) so that water tends to accumulate in flats between natural levee ridges and along the shore of Laguna Madre. The heavy soils and depressed location of these flats retard their drainage and favor the development of marshes and shallow lakes. Irrigation of well-drained land has damaged adjoining flats by increasing the amount of water which drains into them. It has also increased the rate of alkali accumulation in these areas by augmenting the movement of salts in solution from higher land and by lifting them from the subsoil toward the surface where they come in contact with plant roots. Some large open ditches have been dug, and the land along them equipped with drainage systems which solve the problem locally. Facilities of this sort must be greatly increased as development of the Valley progresses.

Efficient transportation services are vital to the prosperity of the Valley. The income of the population is secured largely by the sale of perishable vegetable and fruit crops in distant markets. Thus, increased income is contingent upon improvement of transportation facilities as well as increased volume of production. Good highways and roads facilitate the assembling of truck and citrus crops at shipping points, and rapid efficient railroad services are indispensable to successful marketing of these goods in the North and East. An excellent concrete highway called the "Main Street of the Valley" extends westward from Brownsville to Starr County, and branch roads penetrate agricultural areas on either side. The Missouri Pacific and Southern Pacific railroads enter the Valley at Raymondville and Edinburg respectively and have lines extending through the irrigated and dry-farming sections. Coastwise shipments are made through Corpus Christi, and a Valley port is being developed at Point

FIGURE 12.—View in residential section of San Benito, showing characteristic Spanish architecture.

Isabel which is connected with the interior by railroad and highway.

CONCLUSIONS

Development of the Lower Rio Grande Valley of Texas has been rapid during the last two decades, and there is much promise of continued growth. Truck farming for early market is the chief industry, the leading crops being cabbage, potatoes, and tomatoes. It will remain important, but citriculture is an absorbing center of interest and promises to gain ascendancy. The grapefruit crop is so excellent that growers specialize in its production, and it thoroughly dominates the citrus industry. There is a large cotton crop, and much land is still used for cattle raising. Canning factories are being established, and there is some manufacturing for local markets.[3] The area contains several small cities and thriving towns, most of them less than twenty years old. The population consists of prosperous Americans and many Mexicans, the latter constituting a cheap and efficient labor supply. Such pressing problems as flood control, soil drainage, the conservation of water, and the improvement of transportation facilities are being solved. The mild climate, progressive population, growing communities, verdant citrus groves, picturesque Spanish architecture, and stately palms lend distinctive quality to the landscape, and make the area a pleasant and attractive place in which to live.

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[3] Natural gas and coal obtained near Laredo, local steam-electric plants and potential hydro-electric power from the Rio Grande offer abundant sources of fuel and power.

LAND UTILIZATION IN THE ST. FRANCIS BASIN

Sam T. Bratton

Geographer, University of Missouri

THE St. Francis Basin is the most northern of several similar "basins" of the lower Mississippi River. This Basin is differentiated sharply from adjacent areas mainly by soil types, drainage conditions, and marked topographic features. The nearly level alluvial lands of the Basin are terminated abruptly at its northern end by the Ozark Bluffs; the western and southern boundaries are formed by a curving ridge which effectively separates the St. Francis from the Black River and White River Basins; and, along the eastern side, there are low-lying wet lands between the protecting levee and the Mississippi River. Thus, the Basin is marked as a natural region. The activities of the people are largely agricultural, and are closely related to, and within broad limits are defined by, the natural environment; these characteristics give the area a considerable degree of geographic unity (Fig. 1).

In the northern part of the St. Francis Basin farm practices, in general, are similar to those in the corn belt, and in some sections the cultural landscape, showing fields of wheat, corn, and pasture, and neatly arranged homesteads with shady yards, barns, and, in many cases, windmills, strongly reminds one of that region. In the southern part in marked contrast, farming practices, in general, are similar to those in the cotton belt, and the cultural landscape presents seemingly endless fields of cotton, plantation homesteads, and grouped cabins of negro tenants (Fig. 2). Such contrasts are due largely to the location of the Basin along the contact of the corn and cotton belts. The region, in fact, affords one of the striking examples of the intimate contact of these two distinct farming types.

Although one sees fields of cotton, corn, and wheat in any part of the Basin, the proportionate amounts of improved land used for each of these principal crops vary markedly from north to south, and in different communities both north and south. In the northern district more land is used for corn and wheat than for cotton, while in the central and southern district more land is used for cotton than for corn and wheat. In the northern corn and wheat district there are, however, sections, as in Stoddard, Mississippi, and Scott Counties, in which half or more of the improved land is used for cotton; and, in the cotton-growing district there are sections in which 10 or 15 per cent of the cultivated land is devoted to corn and wheat, as near Wilson, Arkansas. On the R. E. Lee Wilson plantation, at Wilson, Arkansas, about 1,000 acres of wheat, and 4,000 acres of corn are grown each year, in addition to about 10,000 acres of cotton. However, such sections, which differ markedly in land utilization from their surroundings, may be considered merely as "outliers," the presence of which emphasizes the transi-

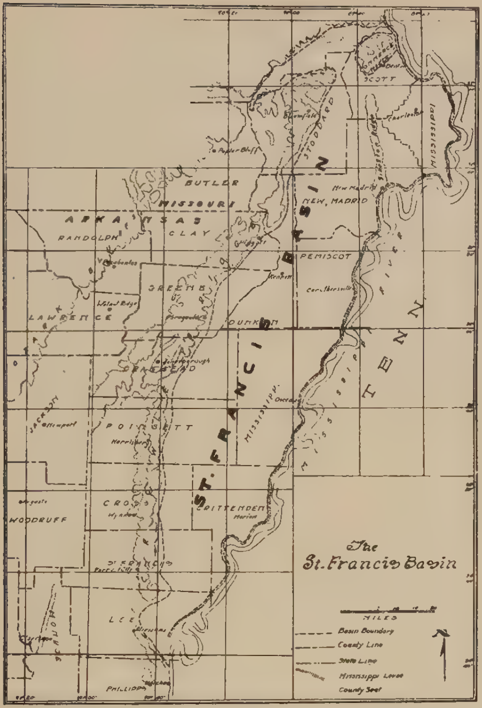
SCOTT
MISSISSIPPI
BUTLER
MISSOURI
ARKANSAS
NEW MADRID
RANDOLPH
CLAY
PEMISCOT
GREENE
LAWRENCE
DUNKLIN
CRAIGHEAD
POINSETT
CROSS
CRITTENDEN
WOODRUFF
ST. FRANCIS
LEE
PHILLIPS
The St. Francis Basin
MILES
Basin Boundary
County Line
State Line
Mississippi Levee
County Seat

FIGURE 1.—Map showing location of St. Francis Basin.

tional character of agriculture in the Basin.

FIGURE 2.—View of St. Francis Basin looking east from Crowley's Ridge.

USE OF THE LAND IN FARMS

Although the most important industry in the St. Francis Basin is agriculture, there are marked contrasts between the northern and the central-southern districts and, in different communities in any general area, in the proportionate amounts of improved land used for the major field crops.

In the northern district, which includes about one-fourth of the Basin, a considerable part of the improved land in most communities is used for wheat and corn grown for cash, and for subsistence crops; but in some communities in this district a part of the improved land is used for the growing of cotton, an additional cash crop. The proportionate amounts of land used for each of these crops in this district is illustrated by the percentages (1923) for Mississippi County, Missouri, a typical area: wheat, 41 per cent; corn, 32 per cent; cotton, 15 per cent.[1]

In the central-southern district, which includes about three-fourths of the Basin, the cash crop is cotton, with some corn as a cash and subsistence crop. The proportionate amounts of land used for these crops are in marked contrast with those in the northern district. Such contrast is illustrated by the percentages (1922) for Crittenden County, Arkansas, a typical area: cotton, 72 per cent; corn, 21 per cent; wheat, less than 1 per cent.[2]

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[1] *The Monthly Bulletin:* Missouri State Board of Agriculture (Jefferson City, July, 1924), XXII, No. 7.

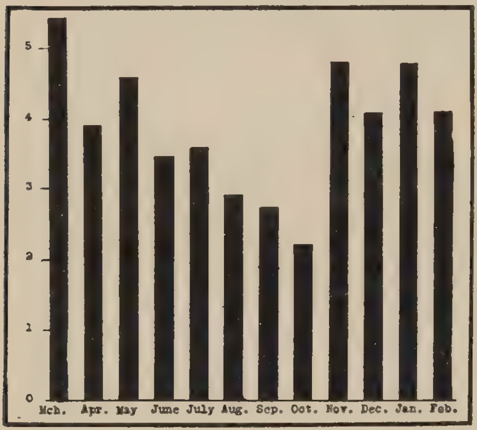

FIGURE 3.—Rainfall record at Osceola, Arkansas, over a period of thirty years, 1892–1922. Figures are in inches. (U. S. Weather Bureau.)

In addition to the major field crops practically every farmer throughout the Basin grows some subsistence crops such as truck and vegetables in varying amounts. In a few communities, widely separated from one another, a few special crops, as melons, berries, seeds, and fruit, are grown for market; but the combined acreage of all such crops, and the income derived from them, are almost negligible when compared with the acreage and incomes associated with the major field crops. Similarly, a few farmers produce some dairy products for market. In a few places one finds a farm devoted to the rearing of blooded cattle, or hogs. However, truck and livestock farming are not common, and as one travels in any general part of the Basin, the vista of cultivated fields rarely is interrupted by any other outstanding agricultural activity.

THE COTTON GROWING DISTRICT

In the central-southern three-fourths of the Basin, most of the cropped land is used for the growing of cotton. This crop increases in dominance toward the south, in which section it has been a part of the farm economy for a greater number of years than in the central section. This southern section is near the cotton South. In fact, it is across the Mississippi River from western Tennessee, and from the northern part of the Yazoo Basin, two regions where cotton has been grown for more than one hundred years.

Most of the farms in the cotton growing district are less than fifty acres each (Table I), and, in general, the farmer is not the owner of the land. As a rule the large land holdings are divided into tracts varying in size from ten to one hundred acres each. These small tracts are leased to cotton farmers.

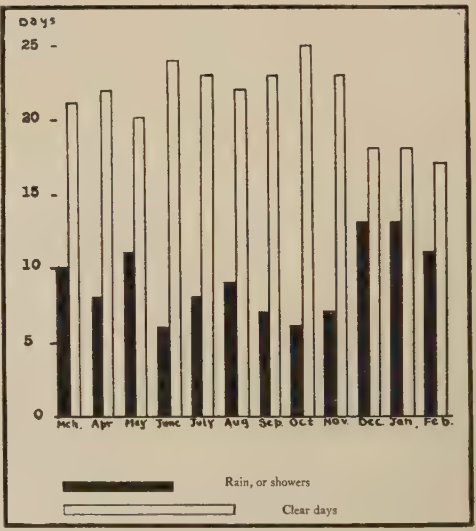

FIGURE 4.—Sunshine record at Osceola, Arkansas, over a period of thirty years, 1892–1922. (U. S. Weather Bureau.)

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[2] Ferguson, Jim G., Commissioner: State Bureau of Mines, Manufacture and Agriculture, *Arkansas Crop Report* (Little Rock, 1923).

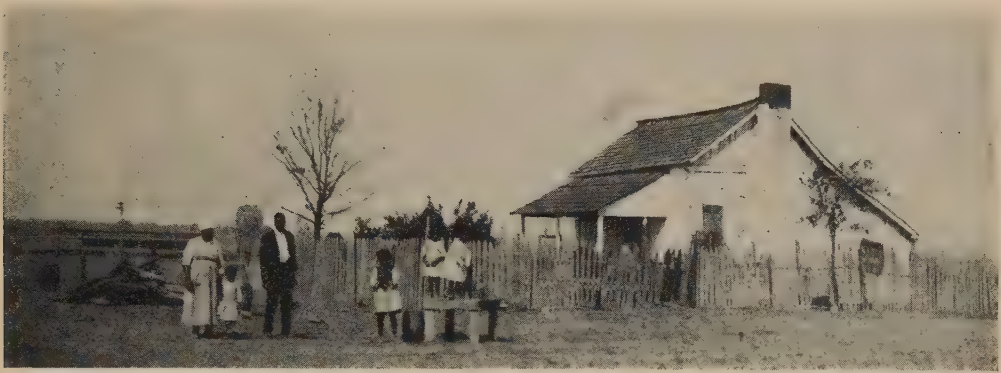

FIGURE 5.—Typical negro cabin on the W. W. Driver plantation. Two of the children are standing on the platform of the well, an iron pipe driven into water-bearing strata. At the top of the pipe is a small suction pump.

TABLE I

SIZES OF FARMS, AND FARM OWNERSHIP, IN FIVE TYPICAL COUNTIES

(U. S. Census, 1920)

County	*Total Number of Farms*	*Number of Farms Less Than Fifty Acres Each*	*Per Cent of All Farms Operated by Tenants*
Mississippi (Mo.)	1,184	306	72
New Madrid (Mo.)	2,025	764	79
Pemiscot (Mo.)	2,533	1,752	72
Crittenden (Ark.)	5,496	5,029	90
Mississippi (Ark.)	6,516	5,407	83

On some plantations, such as the R. E. Lee Wilson plantation, near Wilson, Arkansas, and the W. W. Driver plantation near Osceola, Arkansas, the resident owner farms a considerable part of the land. Other lands on these plantations are leased in small tracts to tenants.

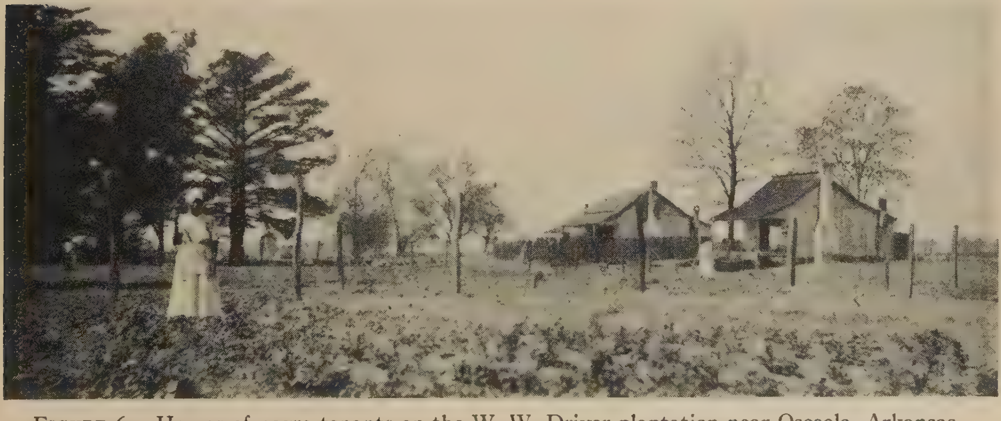

FIGURE 6.—Homes of negro tenants on the W. W. Driver plantation near Osceola, Arkansas.

As a rule the terms of lease are made to suit the tenant. The land holder wants the land cropped, hence the tenant is given several options; he may pay cash rent, crop rent, or cash and crop rent, and he may or may not furnish his own seed.

Land ownership and the leasing system have a direct bearing upon the utilization of the cropped land. Land owners require their tenants (1) to grow cotton, because the cash value of crop rent per acre of cotton is more than that of any other general field crop (Table II), or (2) to pay such high cash rent per acre that they are forced to grow cotton in

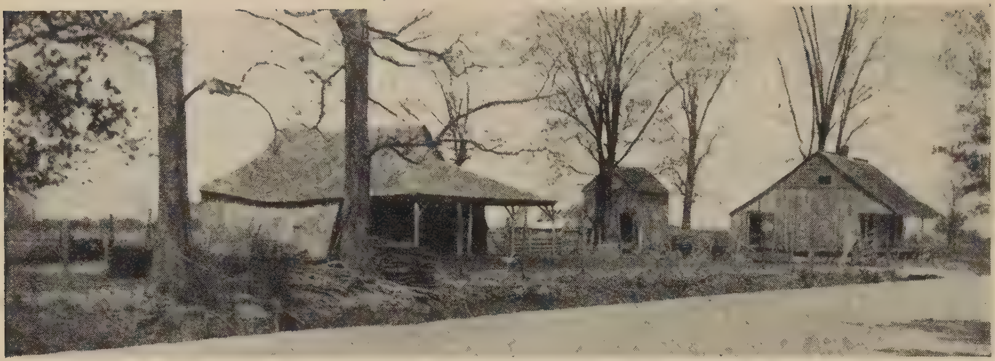

FIGURE 7.—Typical home of white tenant farmer.

order to pay the rental charge.[3] Further, the custom of accepting a prospective cotton crop as collateral for loans, and that of making accounts, notes, and mortgages fall due at cotton picking time, customs that are in turn adaptations to cotton farming, tend not only to favor the continuation of cotton growing by established farmers, but also to induce newcomers to engage in cotton farming. The net value of cotton, per acre, over both corn and wheat, is one of the reasons for the dominance of cotton, especially in the southern section of the Basin.

Most of the farmers who own their farms, and some of the renters, grow

TABLE II

COMPARATIVE NET VALUES OF THE MAJOR FIELD CROPS

(Computations made from data obtained from Missouri Farm Record, 1922, and the Arkansas Crop Report, 1922.)

Crop	*Cost of Producing One Acre*	*Gross Value Per Acre*	*Net Value Per Acre*
Cotton	$33.57	$60.40	$26.83
Corn	23.60	30.05	6.45
Wheat	18.97	14.35	—4.59

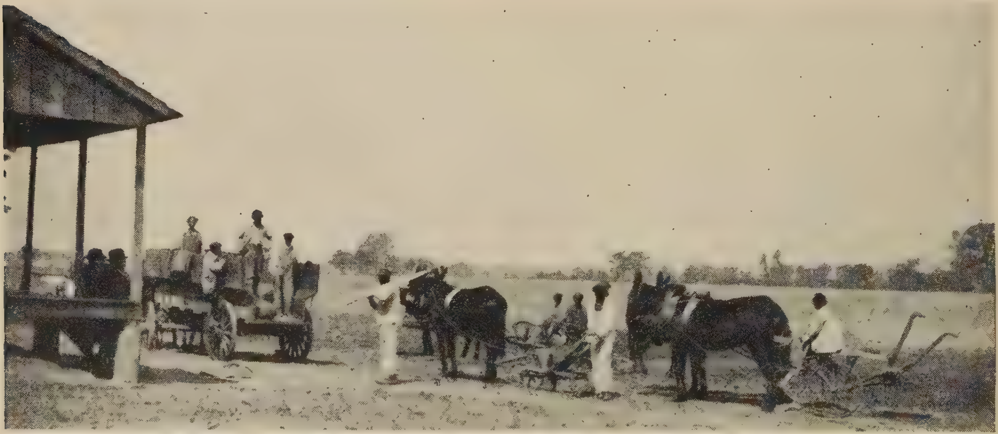

FIGURE 8.—Various types of machinery used in preparing the land, and in planting cotton. The wagon contains fertilizer—nitrate. One of the machines puts the nitrate into the tops of the ridges; another plants the seed. The boys with the long-handled hoes are on their way to "chop" a field already up. (Driver Plantation.)

[3] Cotton land rents from fifteen to twenty dollars per acre. Personal information, Abner Driver, proprietor of "Rainey Colony," Osceola, Arkansas. Mr. Driver has about two hundred and thirty white families on his "Rainey Colony" plantation, and rents all the land on a cash basis Average gross value per acre of cotton on this plantation is about $100, when cotton is selling around 15 cents per pound.

a few field crops in addition to cotton. Such crops are grown because of (1) certain conditions of the natural environment, (2) insufficient labor to grow cotton on all the available plow land, and (3) economic needs of the family.

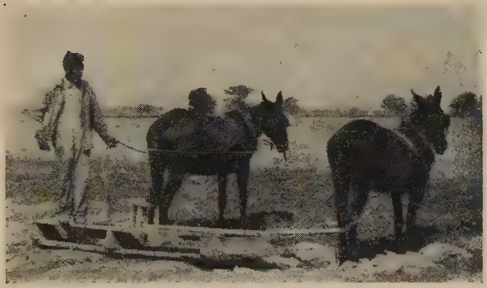

FIGURE 9.—Dragging cotton ridges on the W. W. Driver plantation near Osceola, Arkansas. "Uncle Ed Black" has been on this plantation for more than forty years.

On practically every farm of as much as 50 acres there are small patches of heavier lands. Such places, because of soil texture or poor drainage, are not as desirable for cotton growing as the sandy loams. On some farms small patches are planted in subsistence crops, as corn or wheat, or in forage crops, as clover or alfalfa. In Mississippi County, Arkansas, corn is not grown as a money crop, but mainly as a subsistence crop. Farmers plant a small field of corn if they have time, after giving cotton attention. Such crops are planted, cultivated (if corn), and harvested at such times as labor can be spared from the cotton fields. But the cotton crop requires very frequent attention from early spring until late fall or early winter, and especially during the months of May and June. During the summer months the corn also needs cultivation and the forage crops need cutting. Therefore, the farmer who grows from ten to twenty acres of cotton, and who must rely mainly upon his own labor and the labor of his family, has but little time to give to secondary crops.

Little attempt is made in any part of the district, in some parts none at all, to rotate the subsistence crops with cotton, however desirable the practice might be. The general tendency is to resort to the use of fertilizers to maintain yields.

A few of the plantation owners, and owners of fairly large farms, grow some corn, wheat, and forage crops in excess of what is needed for domestic use, or for livestock on the farm. This practice is exceptional rather than general, and as a rule the planter or owner of considerable farm land grows only enough crops of diverse kinds to supply the needs of the plantation or farm. When one remembers that some of the plantations employ as many as 2,000 laborers who must be fed the year around, and from 800 to 1,000 work animals, one realizes that considerable corn and wheat is a necessary part of the farm economy.

In the cotton-growing district practically all the land that is cleared and that can be plowed is used for field crops, but on many farms containing as much as fifty or more acres each there are patches of timber along the swales and undrained bayous. These patches are used for pastures. They are supplemented by small fields of clover or alfalfa, and by the stubble fields or stalk fields after certain crops have been harvested. However, in some sections as along the King's Highway between Blytheville and Osceola, one travels for miles and sees no pastures of any kind, only fields of cotton, with here and there a field of corn or wheat. In the distance the scraggly trees indicate swale or swamp, and upon examination one finds these distant woodlands are supporting a few cattle and pigs. But the district is not a livestock district primarily; above all else it grows cotton. All other crops are subordinate to this one, and all farm economy is so planned that the maximum time, labor, and land may be given to its production.

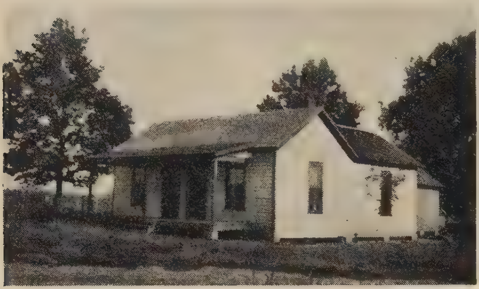

FIGURE 10.—Typical farm home in the mixed farming district. The trees are native. Near the house one may see a corn field.

THE MIXED FARMING DISTRICT

In some ways the cultural landscape in most sections of the mixed farming district in the St. Francis Basin resembles that of a prosperous farming area in the corn belt.

Many of the farms contain 200 or more acres each, with fine homes in well cared for, grassy, shady yards. Nearby are big red barns and white silos, and in pastures of grass or other forage one may see well-bred cattle and hogs. The major field crops are corn, wheat, clover, and alfalfa. On most farms of this type, cotton is not grown.

On the farms which contain from 40 to 160 acres each, the farm buildings are smaller and fewer than on the larger farms, and the cultivated lands, like those on the smaller corn-belt farms, are used primarily for field crops with less attention to grass and livestock than on the larger farms.

Almost any part of the mixed farming district comprising as much as three or four sections of land has about as many farms of varying sizes as any other part, and about as many farm owners.

In selecting lands for various crops, the farmer, as a rule, is influenced partly by general farm practices in the community and partly by the natural environment.

Newly cleared lands are used for corn for two or three years, or until tillage has removed most of the roots and stumps; less stumpy lands are used for corn or pastures, and the land free from stumps is used for corn, wheat, cotton, truck, forage, and pastures.

Soil variations, except in areas of light sandy loams, have but little bearing, in general, upon field crop selection because practically all soil types represented are fertile alluvium and differ chiefly in sand content only. However, gardens and truck patches, as a rule, are on the lighter sandy loams because (1) such lands are easily tilled by hand, and (2) it is desirable to have them near the house, which, in most cases, is situated on the relatively higher, sandier land. On the farms in the northern district where cotton is produced, it is commonly grown on the sandy loams because it can be cultivated there with less labor and at less cost than on heavier lands.

Economic activities, in general, in the mixed farming district are fairly illustrated by the activities in an area comprising a section of land in the light sandy loam region east of Sikeston, Missouri (Fig. 11). Land utilization in this area is typical of that in most of the mixed farming

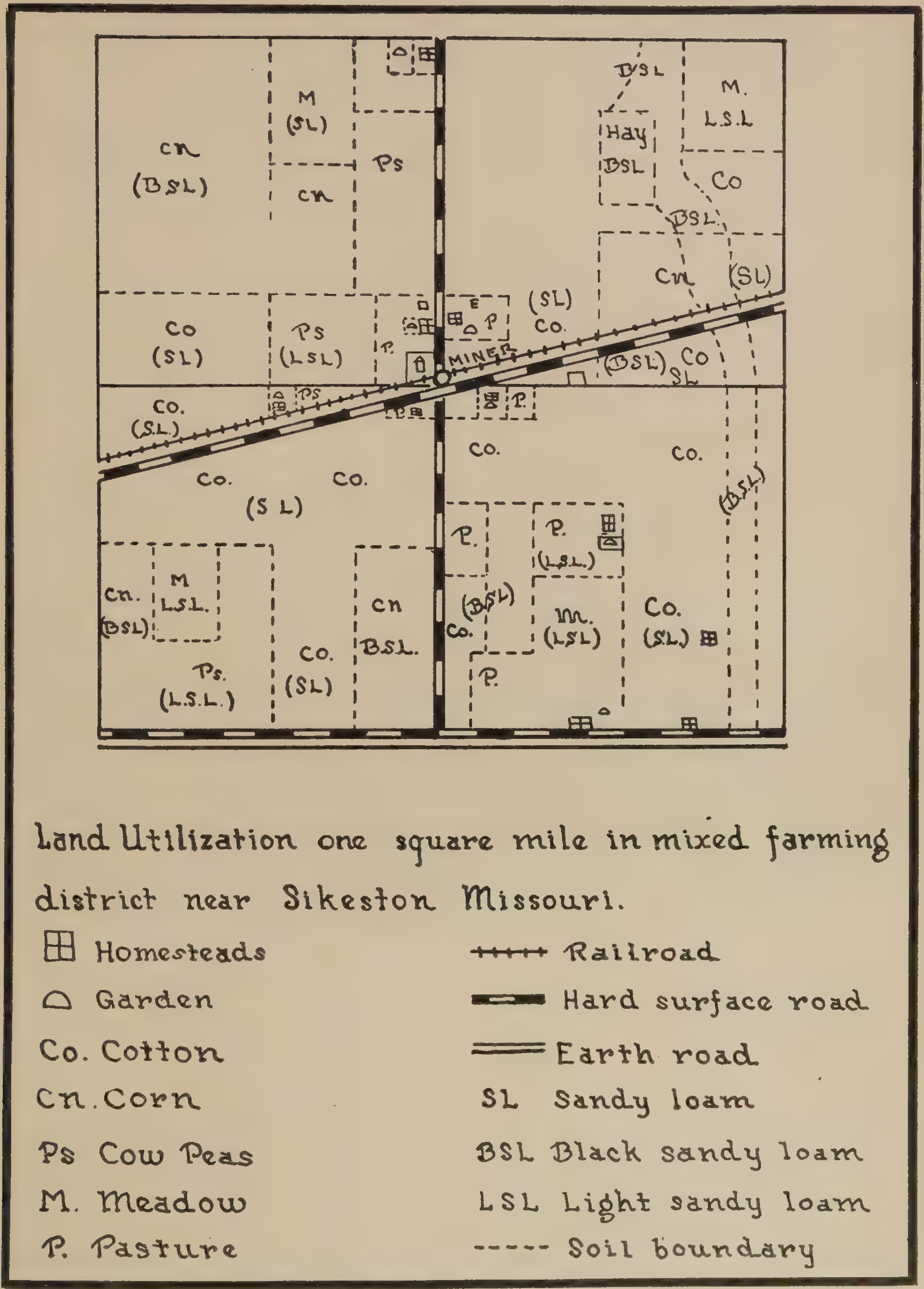
Land Utilization one square mile in mixed farming district near Sikeston Missouri.
⊞ Homesteads
Garden
Co. Cotton
Cn. Corn
Ps Cow Peas
M. Meadow
P. Pasture
Railroad
Hard surface road
Earth road
SL Sandy loam
BSL Black sandy loam
LSL Light sandy loam
----- Soil boundary
MINER
Cn (BSL)
M (SL)
Ps
Co (SL)
Ps (LSL)
Co. (S.L.)
Co. (S L)
Cn. (BSL)
M L.S.L.
Ps. (L.S.L.)
Co. (SL)
Cn BSL.
M. L.S.L
Hay BSL
Co
BSL
Cn (SL)
(SL) Co.
(BSL) Co SL
Co.
(B.S.L.)
P. (L.S.L.)
m. (LSL)
Co. (SL)
(BSL) Co.
P.

FIGURE 11.—Land utilization on one square mile in the mixed farming district, near Sikeston, Missouri.

district, although some contrasts are apparent. For example, during 1924 some sections of the district grew more wheat, proportionately, than the Sikeston Area; the latter, on the other hand, had a greater proportionate amount of land in secondary crops, such as cowpeas and melons, than had most of the district. In the Sikeston area, moreover, a larger proportion of the land was in cotton than was the case in some other sections of the mixed farming district. However, because of partial failure of the cotton crop, due to an early frost, many of the farmers on the Sikeston area grew more wheat and less cotton in 1925.

In the Sikeston area one may see rather large, rectangular fields of corn and of cotton, and smaller fields of hay, melons, cowpeas, or pasture. The homesteads of the farmers; marked by a few shade trees, are located along the roads. Houses in general are of one story, frame construction. Near the house is a garden in which are grown vegetables for family use. A short distance from the house is the barn which, in most cases, is made of boxing with shingle roof, and is framed on posts rather than on sills and foundation.

The principal crops in this section are corn and cotton. In 1924 these two crops occupied more than three-fourths of the cropped land in about equal proportions. In general, corn is grown on the heavy sandy loams and cotton on the intermediate sandy loams. Some of the corn fields are considerably narrower than most of the cotton fields, because the strips of heavy sandy loams, which occupy the lower lands, are not as wide as the sandy loams which occupy the higher lands. Fields, as a rule, are longer in the north-south direction than in the east-west direction, due to the fact that the alternate sandy ridges and strips of relatively lower lands trend in a north-south direction. Some of the intermediate sandy loam lands are used for pastures and some for cowpeas, but as a rule cowpeas are grown on the light sandy loams. Some of the farmers in this area grow patches of watermelons on the intermediate sandy loams, but melon growing is not of general importance in the mixed farming district. In a few places, such as near Blodgett, where there is quite an extensive area

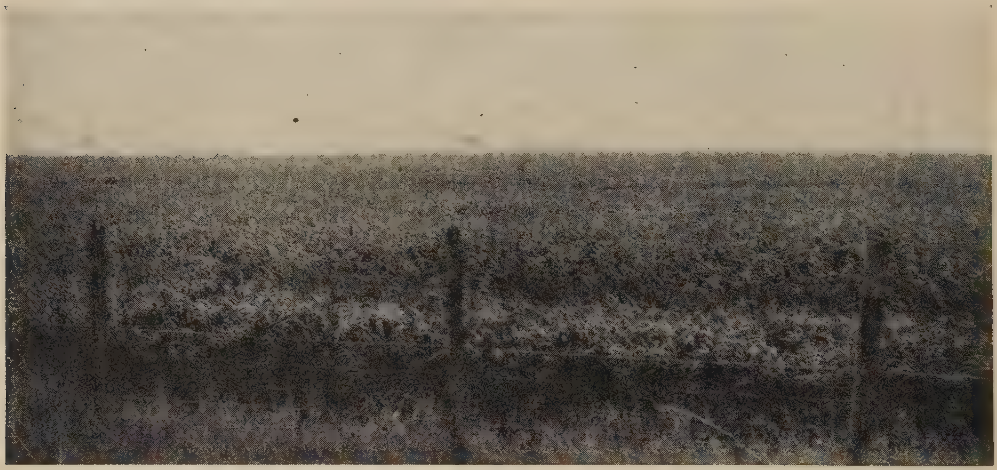

FIGURE 12.—Wheat field in the mixed farming region near Sikeston, Missouri.

of sandy loams, melons are grown commercially.

THE TRANSITIONAL ZONE

The area near Risco shows some striking differences from that near Sikeston. In the former, the farms are smaller and the houses newer, and in general smaller. A greater proportion of the cultivated land is used for cotton and corn and a less amount for hay and pasture than in the Sikeston area. As a consequence, one sees fewer livestock in the Risco area.

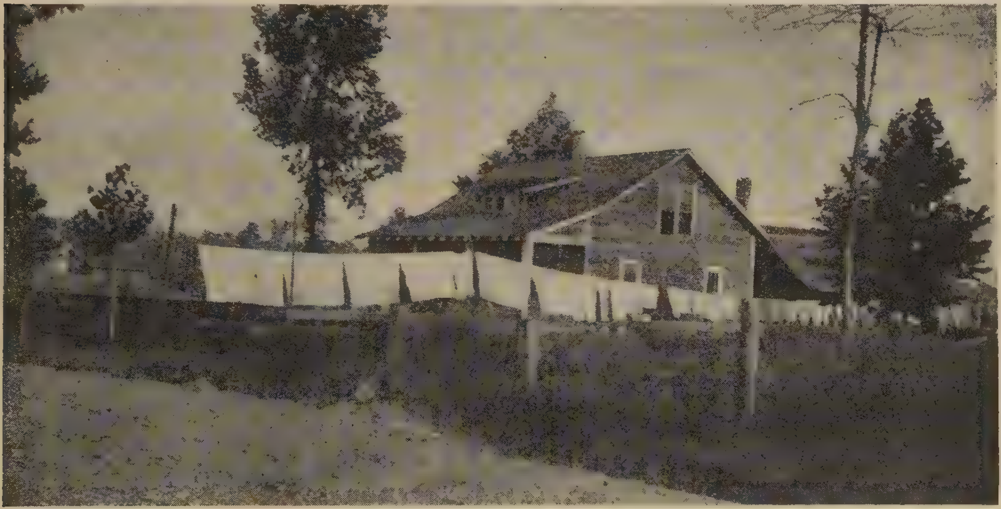

FIGURE 13.—Typical farm home in the transitional farming district, near Risco. The newness of this section is indicated by the fences, the abundance of trees, and the unpainted condition of the house.

In general, any part of the Risco area is similar to any other part. This transitional zone is in the lowland between Sikeston Ridge and Dunklin Ridge and is included within the St. Francis Drainage Project. The use of the land in this area is illustrated by a section near the town of Risco (Fig. 14). Cotton and corn, the principal crops, occupy some 80 per cent of the land and proportionally are about equal. The acreages of corn and cotton which any one farmer grows depend largely upon the amount of labor available. As a rule, a farmer near Risco pays little attention to soil selection for the different crops, because in this section the soil is practically the same throughout, black sandy loam. Some farmers use all their cultivated land for cotton, others use all their cultivated land for corn, and some grow both cotton and corn.

On practically every homestead in this area is a grove of trees which has been left to furnish shade for the buildings. At some of the homesteads there is a wood-lot used for pasture for the work animals and for fuel supply. Practically every house has near it a small garden patch, which, as a rule, is fenced with palings.

The newness of this area is evidenced by the trees remaining on the homesteads, by the stumps in many of the fields, by the new boards in houses and barns, and by the uncompleted fences. The general appearance of the farm as a whole indicates a stage of improvement rather than one of stability.

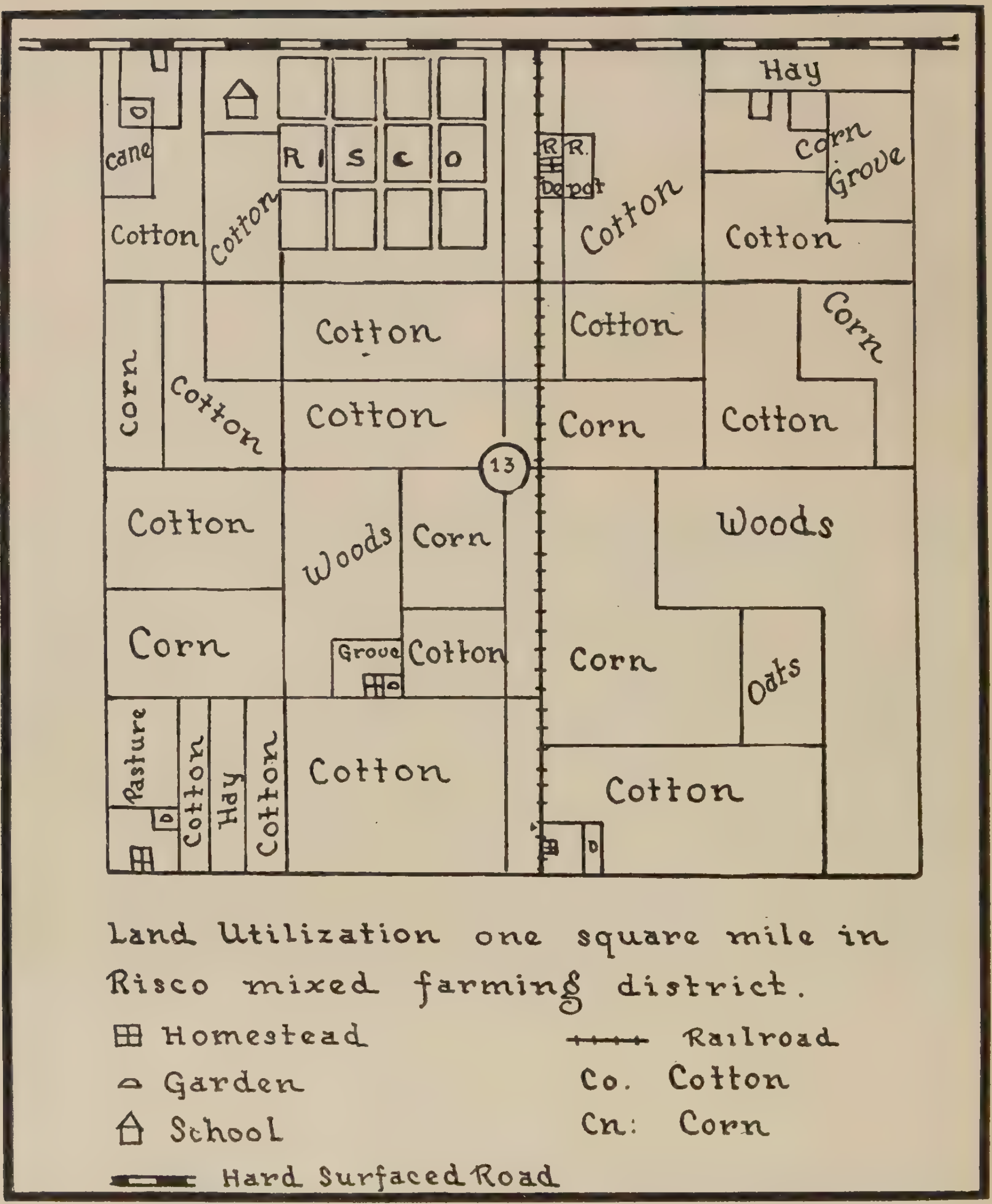
Hay
cane
Cotton
Cotton
R I S C O
R.R. Depot
Cotton
Corn
Grove
Cotton
Cotton
Cotton
Corn
Corn
Cotton
Cotton
Corn
Cotton
13
Cotton
Woods
Corn
Woods
Corn
Grove
Cotton
Corn
Oats
Pasture
Cotton
Hay
Cotton
Cotton
Cotton
Land Utilization one square mile in Risco mixed farming district.
Homestead
Railroad
Garden
Co. Cotton
School
Cn: Corn
Hard Surfaced Road

FIGURE 14.—Land utilization on one square mile in the Risco mixed farming district.

USE OF THE LAND NOT IN FARMS

The amount of land not in farms in the Basin is about 40 per cent of the entire area, but the proportionate amounts of such lands vary widely from place to place. In some parts, such as the Sikeston area, practically every acre is improved farm land; in other parts, such as the southern section of Mississippi County, Missouri, considerable areas are unimproved and not in farms.

The lands not in farms have certain economic relations to the general areas in which they are located. The

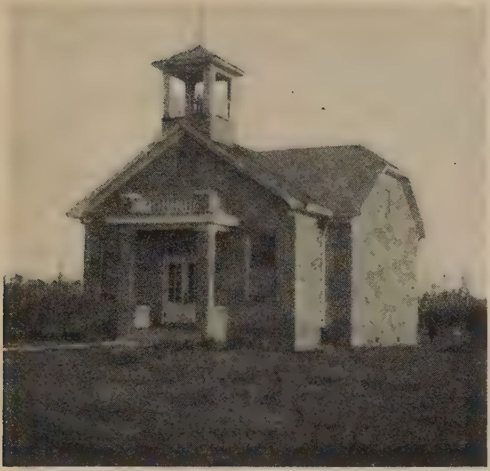

FIGURE 15.—Typical rural school in the transitional farming district. Nearby is a field of corn. Across the road (left, but not visible in the picture) is a field of cotton. In the background is uncleared land.

remaining forested sections furnish timber for the lumbering industry; some of the cut-over areas are used as range lands for livestock.

The most important auxiliary industry is lumbering. This industry is carried on by large commercial companies and by many operators of small local mills. With the exception of some half dozen areas varying in size from a few hundred to a few thousand acres, all the virgin timber which could profitably be taken out by large concerns is gone. At present four large lumbering companies are operating in the region, none of which has timber in sight to last more than a few years. In fact, one of these companies, the Dillman Egg Case Company at Caruthersville, is now getting all of its timber from the banks and islands of the Mississippi River between Cairo, Illinois, and Memphis, Tennessee. The company uses a fleet of barges to bring the logs to the mill.

The Chicago Mill and Lumber Company, which operates a large mill near Blytheville, Arkansas, owns some of the larger stands of virgin timber, and brings logs to its mill by short railway lines from the timber areas some five to seven miles distant. The commercial mill at Marion, Arkansas, uses huge eight-wheeled wagons drawn by six and eight mule teams to bring logs from its holdings some three to five miles distant (Fig. 18).

The large mills, on the average, each cut from 12 to 15 million board feet each year, and manufacture therefrom a variety of products, as boards, timber, shingles, crates, shooks, and staves. Some of the timber of the region is not well adapted for first-class lumber, and from such timber the boxes and crates are made.

Lumber products are marketed mostly in the Mississippi Valley, and are mainly distributed from Kansas City, St. Louis, and Chicago. The Dillman Egg Case Company at Caruthersville, Missouri, sells its egg cases and crates in the states of Iowa, Wisconsin, Minnesota, Nebraska, and Missouri, where large quantities of poultry and eggs are produced.

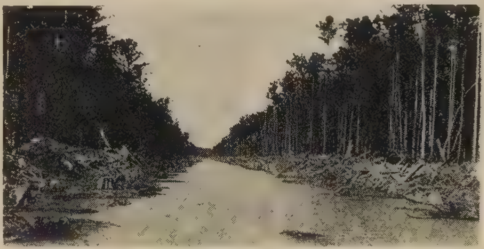

FIGURE 16.—Typical drainage ditch in the St. Francis Basin. Trees cut but stumps not removed ahead of the dredge boat. Growth of timber is typical.

The relation of the lumber industry to environmental conditions in the region may be illustrated by the activities of the Himmelberger-Harrison Lumber Company at Morehouse. This company owns timber lands in various parts of the St. Francis Basin and manufactures boards, posts, shingles, shooks, and staves. Most of its saw timber is brought to the mill at Morehouse by log trains from cuttings as much as twenty-five miles distant. The company has extensive lumber-producing machinery at Morehouse, as well as extensive drying yards. Products of the mill show a marked relation to the character of the timber now available; from the larger trees, high-grade timbers, boards, and shingles are produced; while the small, inferior trees are made into posts, less desirable lumber, barrel staves, and heads.

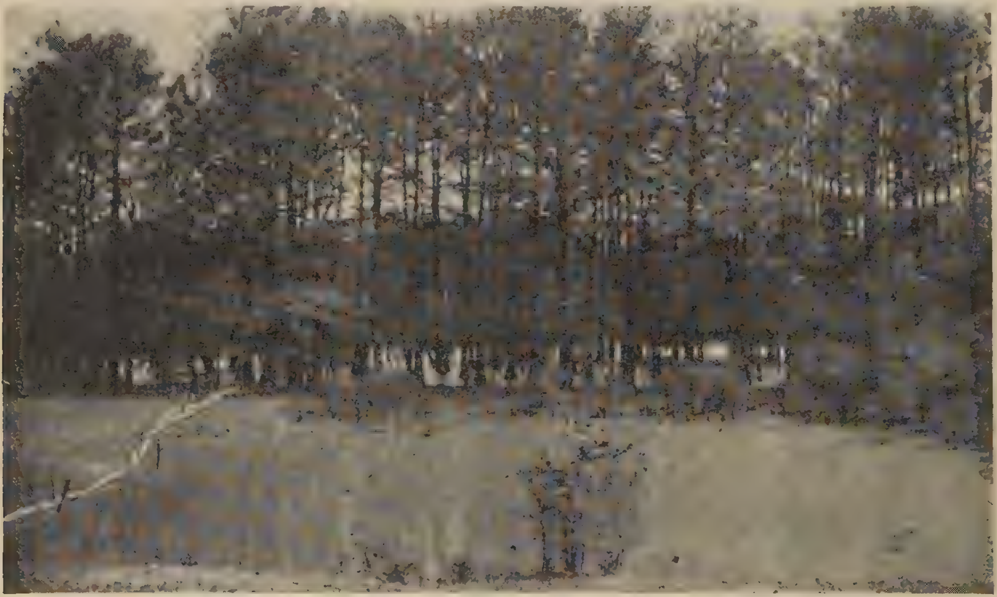

Figure 17.—Typical cypress slough in the area between the levee and the Mississippi River. Areas such as these effectually separate the Basin from the river.

The relative importance of this industry to the locality is indicated by the fact that, at the present time, general business conditions at Morehouse and in the surrounding community depend more upon the agricultural industry than upon lumbering. However, some years ago practically the only economic activity in the Morehouse area was lumbering.

Some of the lumber produced by the mill finds a ready market in the St. Francis Basin. Products not marketed in the immediate vicinity are shipped by rail mainly to St. Louis, or to Memphis, and from these points are distributed to consuming areas.

In addition to the few large sawmills, there are many small ones in different parts of the Basin. These small mills are using the few large valuable trees, and the poorer quality trees, left by the commercial companies, together with the larger, second-growth trees. Their products are mostly second-class boards, railway ties, and telephone and telegraph poles.

Some of these small mills are located along the railways, and thus have access to market. Such as are not so located use wagon transportation to the towns, or to railway shipping points. Because of the wet condition of the roads from the small mills in the low ground to the highways or to the railways during most of the year, many of the lumber wagons have wide-tire, solid wooden wheels, made by boxing an ordinary spoked wheel. The wide tire cuts less deeply than a narrow tire, and the solid wheel prevents mud from accumulating between the spokes.

Logs are brought to the mills in various ways which reflect the conditions under which the industry is carried on, and the difficulties with which it must contend and in part overcome. Logs from a distance of a mile or more are brought on wagons, or on carts by suspending one end of the log from the axle of the cart and by dragging the other end on the ground. If the distance is not too great, the logs are dragged in shallow mud runways, along which they slide quite easily. The team of mules, or the single mule dragging the logs, walks by the side of the mud slide. It is not uncommon to see a mule taking a log along a slide without the direction of a driver. The mule is started by the man in the timber. He knows where to go and how to get there without a driver, and he does it faithfully. On the return journey, however, he is apt to take advantage of his liberty and browse on the way.

Whenever a small mill has worked out the timber within a mile or so of its location, it moves to another site, if one is available; if no site is available, the mill goes out of business. Abandoned mill sites are common, and in not a few places one sees rusty boilers, suggestive of the passing of the lumber industry.

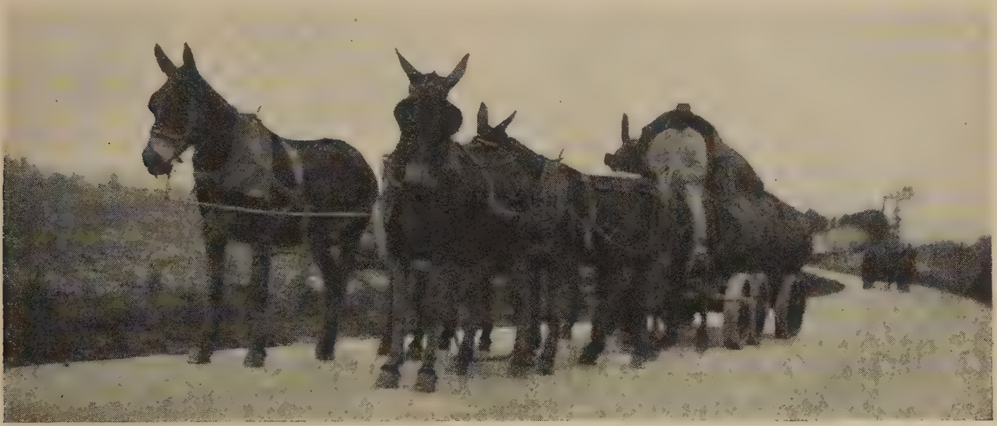

FIGURE 18.—Type of wagon, eight wheels, and team used to bring logs from the lowlands to the mill at Marion, Arkansas.

OTHER USES OF UNIMPROVED LANDS

The use of unimproved lands for the grazing of livestock, because of several contributing factors, is not an outstanding economic activity in the Basin. The people are engaged primarily in the production of crops, and possess only such animals as are needed in this activity.

The major portion of the unimproved lands consists of cut-over or forested areas. The undergrowth on such lands is, in the main, brush and weeds rather than grasses. The paucity of grazing vegetation together with the difficulty of finding the stock in the thick growths, has a tendency to discourage the livestock industry on the unimproved lands. As a result of such unfavorable conditions, most farmers prefer a small fenced pasture, or woodlot, for the few head of work animals and the family cow. Rarely does one see much livestock in the cut-over or forested areas.

In addition to their value as sources of timber and as pastures, the cut-over and forested lands contain considerable numbers of small game animals, game fowls, and fur-bearing animals. Such resources are of some value. Game animals (as squirrels) and game fowls are used for food, and in no small degree supplement food supplies produced on the farm, or purchased from the store. The pelts of the fur-bearing animals, as muskrat, trapped along the marshes, ditches, and in the timber, bring a supply of ready cash at a time when wages are not obtainable, and when there are few, if any, farm products available for sale.

Considerable areas of land, in total, are required for drainage purposes, either for the original streams and bayous, which in some cases have been widened and straightened, or for the artificially constructed ditches, levees, and impounding areas. Although a ditch is perhaps but a score of feet wide, the earth ridge along each side is likely to be several times as wide as the ditch, so that the actual amount of land used for a given ditch is considerable. Larger ditches require proportionately larger amounts of land, and a well-developed drainage project is likely to use as much as five per cent or more of the land in a given area.

Other lands not in farms are used for highways, county roads, cross roads, railways, and village and town sites. The total amount so used is no small part of the land in areas where the farms are small, the transportation systems well developed, and where there are many towns and villages within a few miles of one another. In this connection it is well to remember that many of the roads follow high ground, and that the villages and towns, in most cases, are located on the higher, better drained lands—lands desirable for farming purposes.

THE LIME INDUSTRY AT ROCKLAND, MAINE[1]

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THIS study of the evolution of one of New England's smaller industries, an industry having its beginnings in pre-Revolutionary days, was undertaken because it epitomizes the developments which have taken place in other and greater industries during the past two centuries. New England has always ranked low in its stores of raw materials for manufacturing, and this applies particularly to mineral resources. It is well known that the states of this region lack coal and iron-ore and nearly all other useful metals and minerals. The presence, therefore, of so important a raw material as limestone of suitable quality for the manufacture of lime is a noteworthy industrial fact for New England. The use of lime in connection with the erection of buildings of stone or brick has been known to the civilized portion of the world since ancient times. Modern science has found many more uses for lime, examples of which may be seen in the use of lime in the refining of sugar, the enrichment of soils through liming them, or in sanitation for which chloride of lime is employed. The greater the number of purposes for which lime may be utilized the greater becomes the importance of limestone deposits, the raw material from which commercial lime is manufactured.

The rocks of New England are composed, in the main, of the different varieties of crystalline and igneous types, but there are two limestone regions, one along the western border of the New England province extending upward through Connecticut and Massachusetts, and the other on the coast of southern Maine in Knox County which borders on the west the estuary of the Penobscot River. Rockland, a city of about 9,000 population, is the center of the Maine limestone exposure and development. Although this region is much smaller than the other, the Rockland lime industry surpasses that of any one place in Massachusetts or Connecticut. A brief sketch of some of the outstanding changes, both industrial and social, in connection with the manufacture of lime in Knox County during the past two hundred years is the purpose of this paper.

EARLY HISTORY

The first recorded example of the burning of lime in Knox County was in 1732 by Samuel Waldo, who had secured a grant of land from King Charles and founded the colony of Waldoboro, south of the present site of Rockland. His product found a ready market at Boston since that city had no limestone in its vicinity

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[1] The writers are indebted to Mr. F. E. Harrington, who made accessible much of the material in this paper. Mr. Harrington, now a resident of West Hartford, Conn., formerly lived in Rockland.

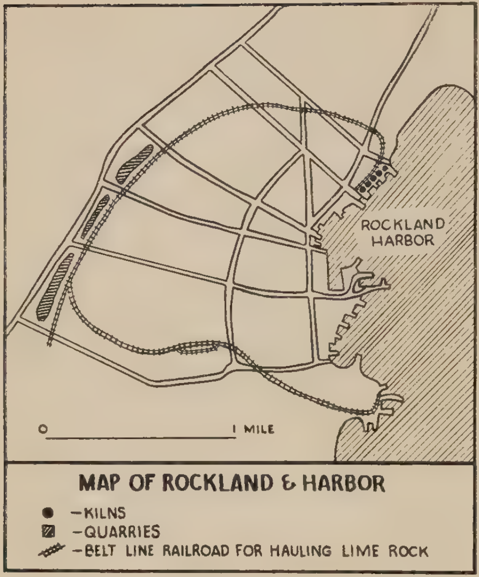

FIGURE 1.—Map of Rockland and Rockland Harbor, showing kilns, quarries, and belt line railroad for hauling lime rock.

and since, further, the water route to Boston was direct and short and ships were plentiful for carrying on trade.

Next came General Knox, Washington's chief of artillery in the Revolution, who had settled on a tract of land given to him by the Government in what is now the town of Thomaston. In 1792 he began to carry on the burning of limestone and the selling of lime. It was not long before cargoes of lime were being sent to New York, and after a few years the business had expanded to such an extent that shipments were being made to practically all the ports along the Atlantic and Gulf Coasts—Norfolk, Charleston, Savannah, Mobile, New Orleans, and Galveston. In more recent years the growing competition of the developing West, aided by excellent transportation facilities, has cut off many of the more distant markets, but Boston and New York have always remained large centers of consumption of Rockland lime.

EXTENT AND QUALITY OF ROCKLAND LIMESTONE

The limestone deposits which have proved so valuable for Knox County are quite limited in extent, running but a few miles parallel with the coast through the towns of Rockport, Rockland, and Thomaston. The industry is centered at Rockland because of its harbor facilities and the easy accessibility of its limestone beds. The Rockland limestone is much folded and crumpled like all the rocks of Maine. The color of the stone is a pronounced gray with inconspicuous stratification lines of lighter color. The formation is of two prevailing types—a hard rock and a softer one. It produces a lime which has but few equals in the United States.[2]

In early days lime-making in the Rockland district was conducted on a small scale according to the prevailing methods of home manufacturing. Each Yankee farm proprietor opened up a little quarry on his property, built a small kiln of beehive type and placed alternating layers of wood and limestone therein and, after three days' burning, tore down his kiln and took out the lime. The product was next barreled for shipment, the barrels (called "casks" in this connection) being made in local Yankee homes. Coasting schooners then carried the casks to the various ports along the coast.

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[2] Analysis made by the Rockland and Rockport Lime Corp., June 27, 1929:

	Hard Rock Magnesia	*Soft Rock High Calcium*
Loss on ignition	1.05	.72
Silica plus insolubles.	3.49	1.16
Iron plus alumina . . .	1.45	1.05
Calcium oxide	83.28	96.40
Magnesium oxide . . .	10.16	.67
	100.00	100.00

IMPORTATION OF FUEL

The local supply of wood for limestone burning was soon exhausted and new sources of fuel had to be sought. Nova Scotia, being nearby and possessing vast timber resources, now began to contribute to the industry. In those days it was no uncommon sight to see in Rockland harbor as many as fifty to one hundred two-masted wood-carrying schooners of the Canadian "bluenoses." So great was the number of vessels entering Rockland that she claimed to be the third port of entry of the United States. The importation of wood was the first forward step in the evolution of the lime industry of the Rockland region.

Along with the importation of the wood came another step in the industry in its transformation from the home type to the factory type. No longer was the limestone burned near the individual quarries. At this time kilns of a much larger size were constructed on the water front. The new location compelled the farmer to haul the limerock from the quarry to the kilns and along with this change sprang up the business of teaming, thus adding two more changes in the specialization of the evolving industry. The farm, as before, furnished the limerock and, in addition, the means of transportation, but the burning of limestone had passed into other hands. The farmer-owners of limestone quarries found themselves getting into an ever-enlarging business with a growing force of laborers under their control, and a largely increased equipment of wagons and horses. This system continued in effect for many years, much to the detriment of the city streets, especially in springtime.

CHANGE FROM NATIVE TO FOREIGN LABOR

About 1890, in the course of the evolution of the industry, came the importation of labor. Hitherto, the work had been done by the native New England stock, but now the heavier jobs began to be performed by foreigners. People are still living in Rockland who can remember the first influx of foreign labor. The earliest to come were the Finns and Swedes, and with them the city saw the introduction of new ways and standards of living which profoundly affected local society.

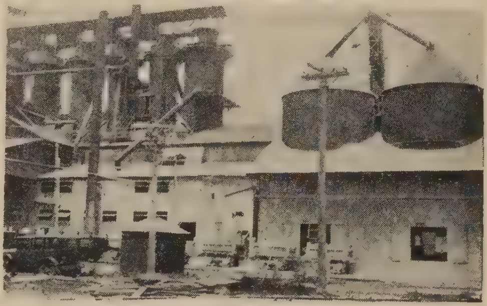

FIGURE 2.—Kilns at left. Waste being discharged into cars in foreground. Device for charging kiln is not shown in this picture.

The increase in production of lime under this new régime was accompanied by a need for more vessels. Three-masted lime-carrying schooners, with a capacity of 2,000 to 4,000 casks, were built in Rockland and its vicinity in greatly increased numbers. These boats, being expensive for those times, were a sort of partnership affair, men owning as little as one-sixty-fourth part of a vessel. With these boats carrying Rockland lime to ports as remote as New Orleans and Galveston, greater dangers were encountered. When water is mixed with quicklime, heat is generated and in the event of a loaded boat springing a leak, an explosion or conflagration is bound to follow. The hazards of the business increased as the radius of ocean transportation grew and losses as well as profits were correspondingly greater.

As the market for Rockland lime increased, the method of transporting the rock by team from quarry to kiln became inadequate and a belt-line railroad was built passing from the principal quarries around the town in a complete circle[3] to the waterfront where the kilns and docks were located (see Fig. 1). The quarries which were not on the railroad found themselves at a decided disadvantage and, while a few continued the struggle for some time, one by one they have ceased production.[4] Not only were the quarries abandoned but, in many cases, the farms also, since the owners had been regarding agriculture as a side line for many years and were unable to return to it as a sole means of support. The families moved into town, more or less abandoning the farms or possibly renting them, farming became decadent and the way was opened for the later purchase of property by others. The lessening of the number of producing quarries accelerated the consolidation of the lime industry and the savings in costs effected by the railroad tended to increase the output of lime.

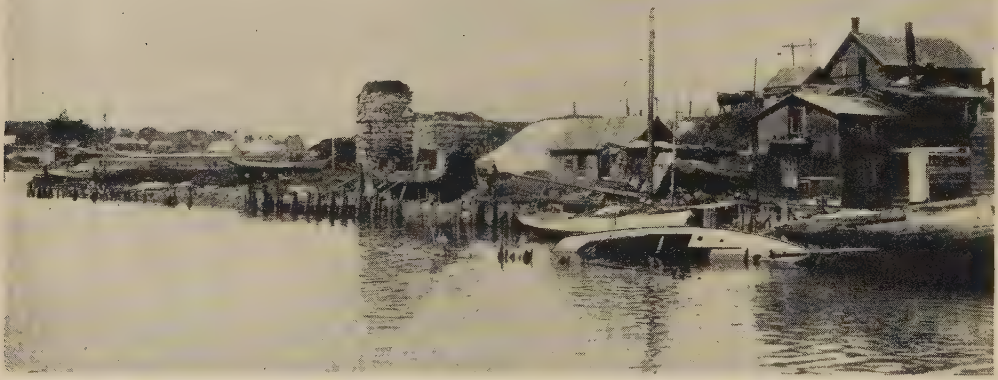

FIGURE 3.—Old furnace with pile of waste shown in center of picture. Modern kilns may be seen at extreme left.

The time was now ripe for the consolidation of the industry under a single management. This change came from the outside rather than from the inside. A large corporation was formed in 1900 by Boston capitalists under the name of the Rockland and Rockport Lime Company (now the Rockland and Rockport Lime Corporation). One by one, the individual operators passed out of the picture until this company became the sole producer of lime in Rockland. It was in a position to make lime more cheaply through control of the entire process from the quarry to the casks of lime at the dock. This company took further steps to lessen the cost of production. Among these was the building of larger and improved kilns, the greater use of machinery to do the work at the kilns and docks, and the purchase of steel barges of 16,000-cask capacity for the carrying of lime to the Boston and New York markets. The modern type of kiln is a towering steel structure over a hundred feet in height (Fig. 2) and so constructed and operated as to permit of continuous charging and drawing off of the lime, much as in the operation of a blast furnace. Side by side with these new and nearly self-operating kilns stand some old rectangular stone kilns as mute reminders of other days (Fig. 3). The mortar between the rocks has been pecked away by numerous birds who make their homes there, showing how completely the old days have gone.

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[3] Later, a short stretch of trestle work along the shore was torn down.

[4] In June, 1929, there was only one quarry not on the belt line railroad producing limestone. The kiln is located in Thomaston, although the quarry is in Rockland. The use of the automobile truck has been introduced within a few months to transport the rock to the kiln in which wood is burned to produce a higher grade of lime.

The history of the Rockland lime industry has been a series of changes from the primitive stage of home manufacturing with its numerous small centers to the factory system, centralized in operation and doing a great part of its work through the use of steam and electricity instead of man power. As the industrial system developed the lime industry grew farther and farther away from those who originated it. We have already noted the coming of the Finns and Swedes as quarry workers. Workmen of other nationalities came to Rockland to perform the physical labor still required beyond that which could be done by machinery. Among these were Italians, Poles, and members of other European races.[5] As they came into the community which had been of almost pure New England stock, the foreign influences became more and more pronounced. These changes could be noticed in such ways as Sabbath observance, churches, amusements, and in foreign languages heard on the streets. Although not to the same degree as some of the industrial towns farther south in New England, Rockland has changed from an Anglo-Saxon community to a heterogeneous mixture of European peoples. The old New England stock did not take to factory labor and the importation of foreign labor was unavoidable. The change in Rockland, and likewise in New England, has been a double one —industrial, or from home manufacturing to the factory system; and social, or the introduction of the diverse foreign elements into the hitherto homogeneous communities.

ASSIMILATION OF CERTAIN CLASSES OF FOREIGNERS

The geographer finds it of interest to note to what extent change and development is going on among the foreigners whom the lime industry has brought to Rockland. The Finns afford a good example for study. One of these, Eric H——, lives on his farm southwest of Rockland. He came to America from his native land at the age of nineteen to escape military duty in the czar's armies. Finland is a land of granite, and Eric was attracted to Rockland by opportunities for work in the quarries. He worked his way up until he became a foreman; then, when agriculture retrograded in the Rockland region and farm values went down, Eric became interested in land and bought a farm of 124 acres, with rather extensive buildings, for $1,600, half of which he was able to pay down. The remainder

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[5] Population in Rockland:

	1860	*1870*	*1880*	*1890*	*1900*	*1910*	*1920*
Total	7,315	7,074	7,599	8,174	8,150	8,174	8,109
Foreign born...		320	323	514	610	821	642

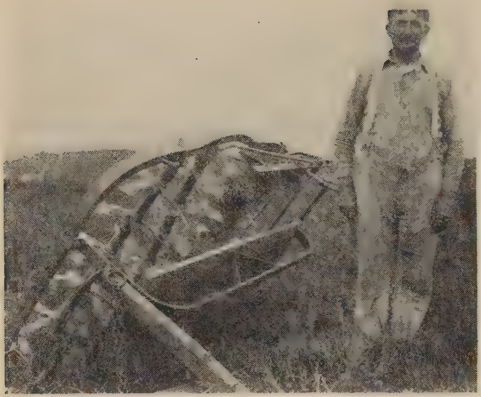

FIGURE 4.—Finnish harrow. The Finns have retained many of their old habits and customs, but have adopted many of their adopted land.

was paid off within one year. He has now established a milk route and uses a cream separator made in Finland which he asserts is the best in the world. In connection with the milk business it was observed that he has three automobiles and three trucks. Everything about the dairy was spotlessly clean. A bottle of cold milk was served to visitors in place of the cup of coffee every Finn is supposed to give his guests. Eric's farm buildings (after living on the farm mentioned above he bought the one next to it on which there were no buildings) are of his own construction and carry out his own architectural ideas, being separated instead of in one connected chain which is the time-honored practice on Maine farms.

Looking over the farm machinery the visitor will see a Finnish harrow (Fig. 4), a type new to American eyes, but Eric is a good American even though he does prefer some Finnish machinery. He has become naturalized and has never gone back to Finland though he has been away nearly forty years. He is married—to a Finnish woman—and they have thirteen sturdy sons and daughters. One of the girls graduated from a business college and, after several years of office work, has married an American. Another of the girls is a graduate of the Farmington State Normal School and is now teaching.

The children of the Finlanders have become thoroughly Americanized. They go through the local high schools at Rockport and Rockland and frequently graduate at the head of their classes. The quarries do not attract the second and third generations, as witnessed by the fact that Eric's six sons are all working on the farm and milk route with him.[6]

Eric is the recognized leader of the Finns in Rockland and vicinity. He finances them (he has a large line of credit at the local bank) and as a result all but three of the farmers in Eric's neighborhood are Finlanders. He has prospered in the land of his adoption and America should be proud to claim him as her own. While Eric's case is perhaps outstanding, nevertheless it is more or less typical of certain classes of foreigners attracted to that vicinity by the lime industry.

METHODS OF TRANSPORTATION

In early days lime was transported almost exclusively by water. It is a recognized fact that transportation by water is cheaper than that by land. However, other factors may enter in, which will make rail transportation more desirable even though slightly more expensive. When the lime was taken by water to Boston, the dealers in that city were located along the water front and took a whole boat-load at a time. As rents and taxes became higher in Boston, the dealers tended to shift their yards to points on railroad tracks near the outskirts of the city. This, plus the fact that lime is a perishable product, caused a change in the method of transportation to the Boston market so that the wholesaler, instead of taking a whole boatload as was formerly the case, may now order any amount he desires and receive it within two days by regular rail freight service. But, while the railroad has captured much of the lime-carrying business as far as Boston is concerned, transportation to the more important New York market is still by water. For this purpose steel barges belonging to the Rockland and Rockport Lime Corporation are used, the towing being done by sea-going tugs. Practically all the building lime is sent to Boston and New York, shipment being made to a great extent in bulk which saves the costs of casks and something on the handling. All of the lime which is sent to paper mills in various parts of Maine is handled in bulk also.

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[6] Van Cleef in his book, *Finland—The Republic Farthest North*, supports many of the facts mentioned above with relation to the Finns.

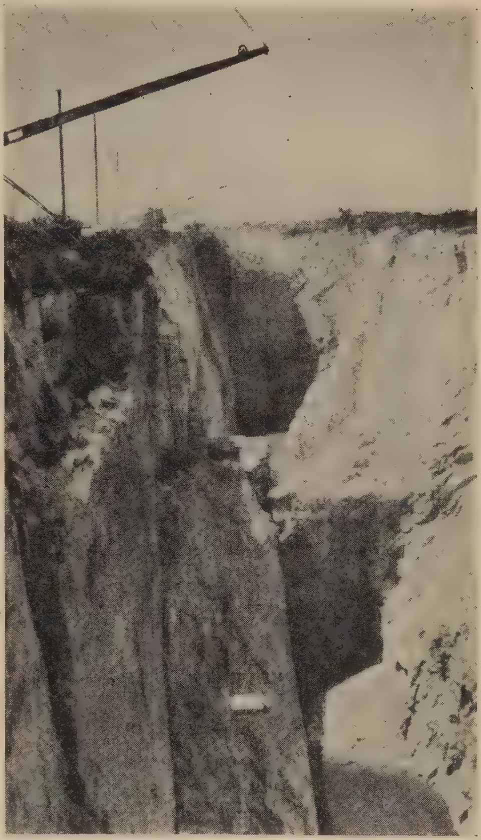

Figure 5.—View taken at one end of narrow, deep gash. Booms at left raise limerock which is placed on cars to be taken to kiln. The loaded drag is shown.

The market for lime is seasonal in some cases and constant in others. In the building trades and paper pulp mills the demand is fairly steady the year around. In early spring there is a strong demand for lime for farm fertilizer. A little later in the spring much lime is shipped for use in the spraying mixtures in the orchards. Both quicklime (CaO) and hydrated lime are made for the market. Hydrated lime is safer to handle, does not easily deteriorate, as is the case with quicklime, and the hydration is also a necessity in some uses as in the case of treating the soil with lime or the spraying of fruit trees. While in the early days quicklime was the only product put out by the producers, now, due to brand names, to various sizes of packages for the retail trade and limes for various uses, as many as thirty to forty types are sold. The cask has also undergone a change, the staves being grooved now to preserve the lime by preventing moisture from coming in contact with it.

The later developments in fuels for lime burning in Rockland are of interest. The use of coal for fuel in the kilns has long since displaced the Nova Scotia wood. When barge service to New York was started, it was obviously better to load the barges with coal for the return trip than to have them come back empty. Finally, in the testing of fuels it has been found best to generate gas from the coal and burn that in the preparation of the lime instead of using the coal directly.

The latest step in the commercial use of Rockland limestone is the making of cement. We have seen that two kinds of stone are found in the Rockland structure, soft and hard limestone. These occur in close proximity in each quarry. Hitherto the rock less valuable for lime has either been given away to the municipality for highway construction or broken up and sent to a Massachusetts blast furnace. Now a new company has entered the field with the idea of using the best stone for lime and the remainder for cement, and so doing away with much of the waste which up to this time had been deemed unavoidable. This company has introduced an innovation in regard to transportation of materials preceding the burning of the rock. By constructing the mills and kilns at the edge of the quarries it is possible to do away with the conveyance of limerock by rail and carry the material in cars on a long inclined track from the bottom of the pits direct to the kiln or mill. They, of course, lose whatever advantage there may be in being situated at the water side.

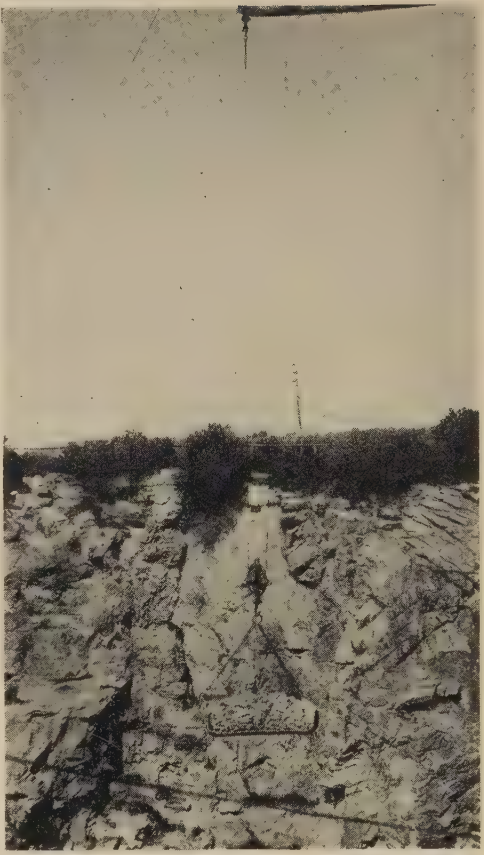

FIGURE 6.—Drag being raised to surface.

The visitor to the quarries at Rockland finds them most impressive to the sight. They form long, open gashes with vertical sides, and the men working in the bottom are so far down as to appear insignificant in size (Fig. 5). They are among the deepest quarries in the country, the largest one extending to about 320 feet below the surface of the ground. Long booms swing out over the terrifying chasm and let down drags which are filled with rock by the quarrymen and raised to the surface (Fig. 6) on signal to the hoisting engineer.

Occasionally, men may be seen taking the thrilling ride down or up on one of these drags, as it is impossible to reach the bottom of the pits by any other means. The pits which are not being worked are full of greenish or bluish water to within fifty feet of the top. As the observer notes the immense size of these quarries, he may realize something of the enormous amount of lime which Rockland has furnished to the working world and is still furnishing.

It seems that industry always brings something physically or aesthetically objectionable in its wake, and the Rockland lime industry is no exception. The rutted streets of the hauling days are no longer found. The dust and pall of smoke when methods were less efficient have largely disappeared, but the awful-looking chasms of the worked-out quarries and those still in production are in the suburbs of Rockland to stay, since it is impractical to attempt to fill many of them.

From the foregoing, something may be seen of the different steps through which this one industry has passed. What is true of this one is typical of scores of others in New England towns and cities. Many of them, like Rockland, are more or less dependent on a single industry. In some cases competition, and in others substitutes, have caused the original industries to decline or become defunct. Gypsum and cement are taking the place of lime in some places today. What will happen to Rockland if the lime production declines, since that is the chief industry in the town? Many New England towns have had to face this same problem. Some have survived and some have had to give up the struggle. It is a question which cannot be answered offhand as there are too many factors involved and the ultimate test will be whether Rockland, like New England as a whole, has the adaptability to maintain her position in a changing industry against newer and possibly more logical industrial centers.[7]

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[7] In July, 1930, the cement plant mentioned above was running night and day turning out cement for new highways for the State Highway Department. Cement illustrates the principle that bulky inexpensive articles will be made as near as possible to the place of consumption because they cannot stand heavy transportation charges. It may be that this new industry will prove a boon to Rockland if the lime industry does decline. Incidently, this has happened to many towns throughout New England; a new industry comes in, either utilizing the equipment of one which has become defunct or using the labor of a declining manufacturing town. Thus New England has survived, and will probably continue to survive, the rise and fall of industry.

MOUNTAIN TOPS AND LOWLANDS OF COLOMBIA

Albert C. Smith
Assistant Curator, New York Botanical Gardens

THE harbor of Cartagena spreads a beautiful vista before an approaching vessel. The low hills which encircle it are decked with verdure to the water's edge. In the distance the hills mount in long and sloping curves. As the vessel steams through the narrow entrance, "La Boca Chica," it is frowned upon by a series of forts which once held the harbor impregnable. Across the clear and azure water the city appears, white and inviting.

Indeed Cartagena deserves its old title of "The Queen of the Indies." Navies could be sheltered in its vast landlocked harbor. Only two channels connect this expanse of smooth water with the sea. Of these, only "La Boca Chica" is navigable; the other, "La Boca Grande," was filled with stone during the days of pirate domination.

The early history of Cartagena is the story of battles and sieges, of plunderings and revolutions. It was once the most prominent city on the Spanish Main, due to its ideal position and harbor. Its rapid accumulation of commercial wealth made it the goal of French and English pirates who infested the region. So often was it captured and plundered that the inhabitants built sturdy walls around it, and eventually blocked "La Boca Grande." After this maneuver Cartagena was less open to enemies.

In the last century Cartagena has been the seat of many political agitations and revolutions, but alas!—while different factors quarrelled to retain possession of it, Cartagena rapidly lost commercial importance. In recent times it has been succeeded as Colombia's chief port by its sister city, Barranquilla. Only in the last few years has Cartagena realized its situation and endeavored to regain its lost prestige.

But "The Queen of the Indies" has changed since the days when LaFitte coveted it. To be sure, the old forts still stand at the sides of "La Boca Chica," but their crumbled sides and fallen towers are silent tokens of past power. The staunch walls still encircle the "old city," but their grass-grown slopes no longer challenge foreign fleets.

Within the walls is the business section; narrow, twisting streets cross and re-cross, flanked by stores, offices, and occasionally by a grim-fronted dwelling. The stores are innocent of that American device, the show window, but their stout open doors disclose as well-stocked shelves as many Northern cities can boast. The business houses, too, are surprisingly modern, and one is agreeably surprised to find within them cool and pleasant patios, bordered by offices which are the last word in efficiency, with typewriters, electric fans, and water coolers.

The one feature which every visitor to Cartagena remembers is the market. This is essentially an open barn-like building on the edge of the harbor, but the greater part of transactions take place in the open, on a quay which lies adjoining. To this

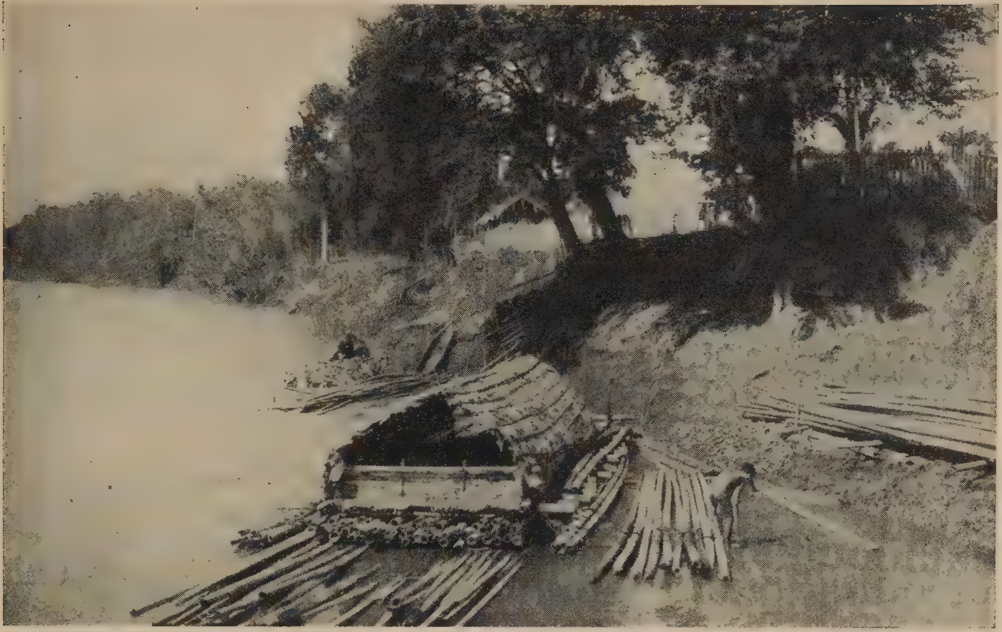

FIGURE 1.—Building a bamboo houseboat by the riverside.

come the sailing boats and the dugout canoes of the coast negroes, who bring their wares from island villages and tiny settlements of the coastal marshes. In the early morning they come, and after a great deal of squabbling over the choice places, each boat is tied to the quay and the work of selling begins.

Meat, fish, charcoal, cocoanuts, yuca, and fruits are exposed to the eyes of the buyer, and too often, alas, to a horde of flies as well. Servants, housewives, and hotel boys crowd to the edges to get the choicest bargains, and the bargaining becomes shrill and furious as neither buyer nor seller will yield a "centavo." On the quay are numerous booths where ices and cold fruit drinks are offered the hot and weary marketers. Taxi drivers and coach drivers jostle those who appear more prosperous, idlers chat and joke, children play underfoot in naked comfort, and, altogether, the scene is one of busy confusion.

But, as the sun's heat becomes more intense, the activity wanes. Shoppers wander home with their purchases, while the salesmen cover their boats with canvas and retire for a "siesta." The young seek peace in the cool waters of the harbor. Fortunate is the boatman who has sold his load before noon, for his is a long "siesta," and he is untroubled until the cool approach of evening makes feasible a return sail to his hut.

Recently "The Queen of the Indies" has been making a gallant bid to regain power. A surprising amount of commerce creeps through the tortuous channel of "La Boca Chica." On its land side, Cartagena is connected with the main artery of Colombia, the Magdalena River, by a modern railway, along which traffic with the interior progresses.

But the railroad is a recent development, and, long before its inception, Cartagena had an outlet to

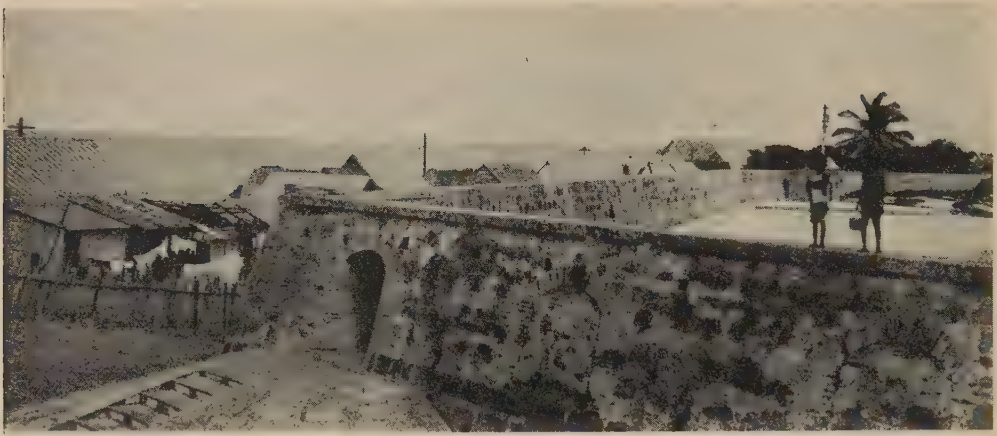

FIGURE 2.—A corner of Cartagena's famous and much-exaggerated walls.

the river. A natural canal, known as the "Dique," connects the waters of the harbor with those of the Magdalena. Constant dredging is necessary to make transportation through the canal feasible, and, of course, the railroad is more popular with travelers and commercial houses.

Where the "Dique" enters the Magdalena is the town of Calamar—a typical river settlement. It is a busy place, receiving the river traffic from both directions and that of Cartagena in addition. The activity of Calamar, as of other river towns, centers along its waterfront. The broad, swift river flows past a low embankment here, and is deep enough to allow boats to tie directly to the shore.

The top of the embankment is a pleasant street, in truth, the "Fifth Avenue" of Calamar, except that on one side is the flowing Magdalena. On the other side are the town's shops—hat shops, shoe shops, food shops—all kinds of shops where you can stock up for a long river trip.

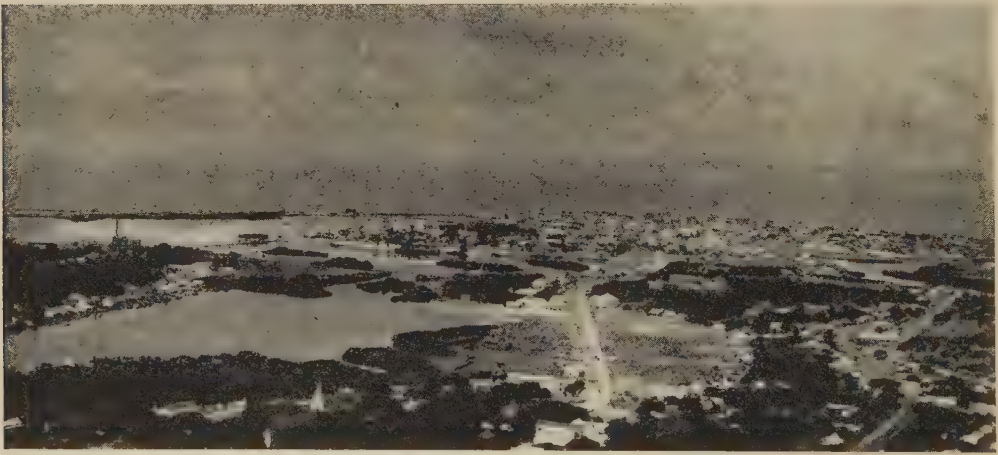

FIGURE 3.—The city of Cartagena from the summit of a hill in the suburbs.

It does not pay to be impatient when one is waiting for a Magdalena boat. One will always wait hours, often days, and occasionally, in times of low water, weeks. The boat, when it does come, is not much to look at, but it is far superior to what acquaintances have led people to expect. The reputation which Magdalena steamers are given is hard to understand, for unless one is a very finicky traveler, the river trip is one of the most fascinating in Colombia. Mosquitoes are a drawback to comfort, but usually a pleasant breeze keeps the deck free of them.

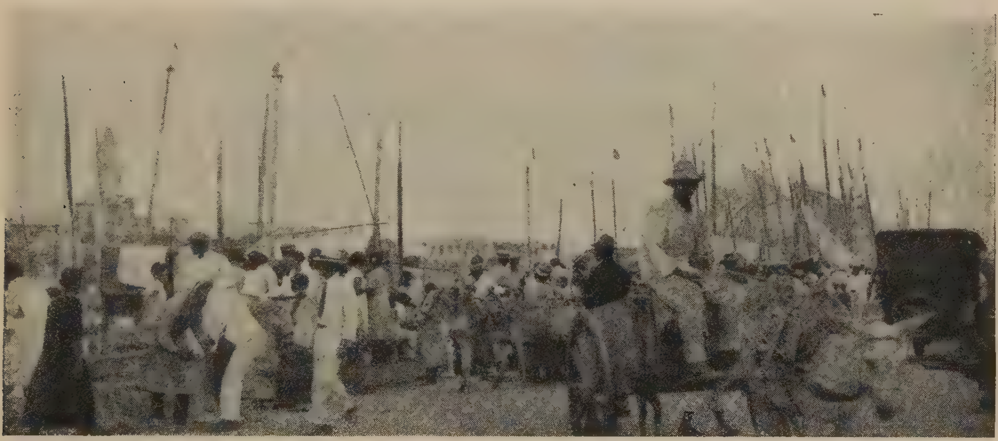
FIGURE 4.—Cartagena's outdoor market during the morning hours.

The boats themselves are a trifle ancient; they are stern-wheelers, of a type well known to old Mississippi travelers; but the accommodations and food are good, the scenery varied and shifting, and one's fellow-passengers usually "sympatico," so that the trip often passes too quickly.

The subsequent towns on an up-river trip are reproductions of Calamar—some are smaller, some larger, some dirtier, but all have a main street on the waterfront and huts of the townspeople in back. During the months of October and November, the river is at its highest, and landing is an easy matter. But at other seasons water is scarce, and often boats must discontinue their schedules for long periods, lying idly on hidden bars.

Aside from the towns, the river, for the most part, is bordered by solid jungle. Crocodiles sun themselves on exposed sand spits, and sometimes in the dusk the distant roar of howler monkeys is heard. Occasional clearings interrupt the monotony. Here two or three straw huts huddle, while the jungle overruns their very backyards. In the flood season these huts are practically islands; the river even creeps inside, and from the boat can be seen inhabitants who live in knee-deep mud-water. Often they wave cheerfully, seeming to enjoy their watery isolation.

Sometimes the boat passes solitary banana plantations, sometimes oil stations or huge woodpiles for the use of old wood-burning steamers. But the woodpiles are becoming less frequent, for the recent oil development in Colombia has given an impetus to the use of oil-burning boats.

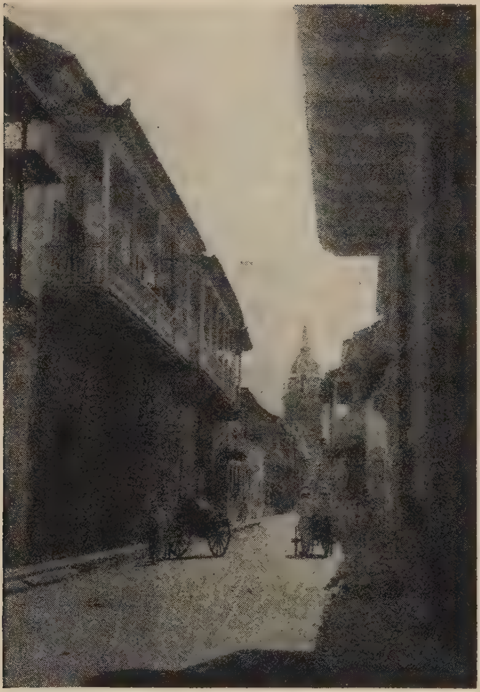

FIGURE 5.—Street scene in Cartagena.

Many of the river towns owe their existence to the present oil boom. Such places are Puerto Wilches and Barranca Bermeja, although the former owes much of its growth to the development of Bucaramanga, an inland city. The only means of transport to and from Bucaramanga is through Puerto Wilches. On this spot but a few years ago were several mean huts; now there are dozens of houses and stores, a good hotel, and a terminal for an interior railroad.

Visitors to Bucaramanga are given a choice of two methods of travel. One is by airplane; the other, by mule. There is no half-way, for the railroad runs inland only a short distance. Airplane travel is maintained in daily and fairly dependable service, but it is still very expensive. Many times a traveler must patiently await his turn, and even then he can carry no baggage. Therefore, mule-back is the predominant method of transportation.

It is wise to begin the journey early in the morning, for ahead lie fourteen "leagues" (a league is that ephemeral distance which Colombians consider one hour of steady traveling). To secure riding mules is not such an easy task as it sounds, for all are engaged in cargo carrying, a more profitable trade. The traveler is quite at the mercy of the suave Spanish-negroes who dominate the region, and can do little but accede to their exorbitant demands. Finally mules are secured, and a boy to guide and to take care of the cargo is also found. So the procession starts. Soon the huts of the village are left behind, and the road leads through unbroken jungle. "Road" is a very general term, for often the mules wallow through streams, sink in mud which coats their flanks, or climb wearily over bare rock ledges. The lowland gives way to mountain slopes and a gracious breeze supplants the hot breathlessness.

The trip to Bucaramanga is usually made in two days. Traveling becomes more difficult as the road increases its dips and curves. It leads through a rough, broken country, marked with huge trees and tangled undergrowth. One is very apt to become discouraged and wonder what kind of city can lie in this wilderness. About the middle of the second day the highest point is reached, an open ridge from which an impressive view to the east is exposed. A first glance at the hills and valleys below discloses no hope of a speedy end of the journey, but the keen eyes of the guide find a cluster of white spots in the distance. "It is Bucaramanga," he says.

Then the traveler feels much encouraged, perhaps unduly so, for a long six hours lie between him and his destination—six hours which must be spent coaxing and spurring a tired mule over steep dangerous roads. It is dusk when the traveler rides through the outskirts of Bucaramanga. All that can be seen are the narrow, straight streets, sparsely lighted by electric lamps, and the plain walls of quiet dwellings. A pedestrian guides his clattering mule over the cobblestones to a hotel. Here an agreeable surprise awaits, for the hotel is a cool and pleasant building, with a most genial "Señora." Everything is done for the traveler's convenience; one need only rest and partake of supper before seeking sleep in one of the large open rooms.

FIGURE 6.—A view of the valley in which Bucaramanga lies.

In the morning Bucaramanga presents a different aspect. The city is situated on a broad plain raised above the level of the valley which is formed by the Río Lebrija. It is a growing city, with a present population of about 30,000. Its streets are straight and paved, dotted with private automobiles and taxis. Along the "Calle Real" (Main Street) are shops of all description, all of them extremely well equipped. Residences and public buildings are modern to the last degree, with electricity, pianos, victrolas, and all luxuries.

This is all the more astonishing when it is realized that every piece of machinery, every plumbing accessory, every piano and luxury is carried in pieces on a mule's back over the wretched road from Puerto Wilches! To carry a single touring car over this sixty-mile stretch twelve mules are necessary, and the body of the car must be carried by hand by peons in slow stages!

Yet the interior cities of Colombia, as represented by Bucaramanga, are superior in every way to the coast towns. The state of their progress on every hand astonishes. The natives of this region are a mixture of Spanish and Indian; they are in the main very intelligent, and courtesy is extended on every side.

To the east of the valley in which lies Bucaramanga can be seen the foothills of a vast mountain range, the backbone of the Eastern Cordillera. The distant peaks which appear through the haze on exceptionally clear days are the high points of the Páramo of Santurbán, the "altissimo" of eastern Colombia. The páramos of Colombia form a distinct geographical feature of the country. They are the tops of mountains, usually more or less flat rolling plains, windswept and inhospitable. At places Santurbán rises above 15,000 feet. Its edges are roughened by projecting spurs and shoulders, each of which is locally known by another name. The main páramo is an important feature of the Eastern Cordillera. Economically, it forms a barrier which cuts off one entire state, Norte de Santander, from the rest of Colombia. All the commerce of this rich region passes through western Venezuela to the sea.

A traveler can only gain a correct impression of the páramo people by spending some time in one of their huts. On such a "rancho" the author stayed for several days. The head of the household was a good-natured Spaniard named Pedro Gonzales, whose hospitality will long be remembered. His house is a two-roomed, whitewashed, earthern hut, placed on the very brink of the páramo, whence it commands an unexcelled view. Nearby is another hut which serves as a kitchen as well as a living and sleeping room for the younger members of the family.

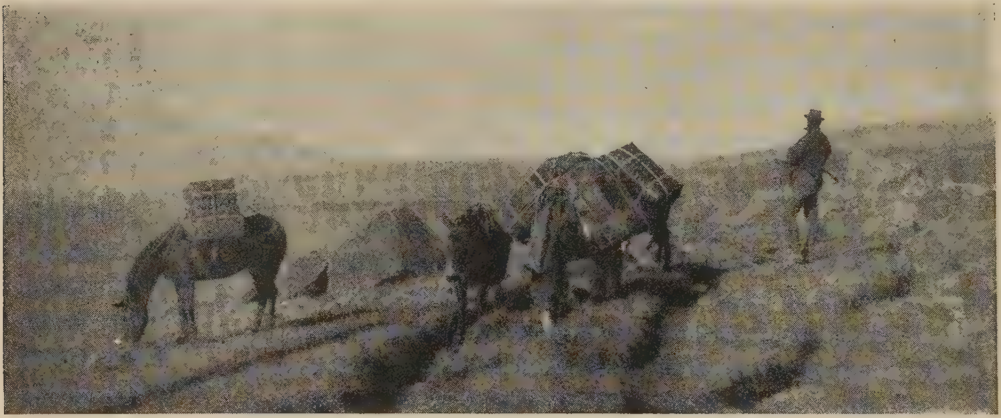

FIGURE 7.—A caravan crossing the Páramo of Santurbán at an altitude of 15,000 feet.

In the evening all gather around the open fire in the kitchen, and supper takes place simultaneously with the discussions of the elders and the dissensions of the youngsters. Pedro Gonzales' wife boasts eleven children, and in addition there are aunts and brothers and several "hired men." The entire group around the fire numbers well over twenty, and the room is crowded and airless. Once or twice during the evening the door opens to admit a "neighbor" who is passing with a caravan and seeks a place to sup and sleep. The kitchens of these páramo homes are always open to passers-by. The women perpetually peel potatoes in preparation for the next day, and a huge pot of them boils over the fire. The only other cooking is the baking of a hard, flat corn bread, which is tough and unpalatable. These are the staple foods of the mountaineers, with occasional meat and soup.

Animated conversation lasts long into the evening, due to the presence of the "Americano." Eventually, the children, one by one, creep off to a corner of the hut to sleep among rags and skins—an arrangement which would breed disease in a warmer climate, but which seems to breed only healthy faces and perpetual hunger here. However, the lives of the mountain people are far from happy; for the grown-ups it is a never-won struggle against poverty, for the children a dull existence in which play is prohibited by the cold and the necessity for work as soon as they are able.

Below the eastern rim of Santurbán lies Pamplona, five days distant from Bucaramanga across the massive range. Pamplona is also an astonishing town, for it is just as isolated as Bucaramanga from the outside world, yet, like its sister city across the páramo, it has all the conveniences which a mule can carry. But alas, Pamplona has none of the climatic charms of Bucaramanga. It has a higher altitude and is correspondingly colder, with the driving fog which sweeps down from the páramos. The nearby hills are sharp and barren, and a less hospitable place for a city could scarcely have been found.

The inhabitants here show a very high percentage of pure Spanish blood, being of old and conservative families. Their hospitality is unbounded, and, were it not for its climate, Pamplona would indeed be the loveliest of Colombian cities. It is one of the most important places in its department, Norte de Santander, being second only to Cúcuta. To Pamplona come all the products of the rich region south of it.

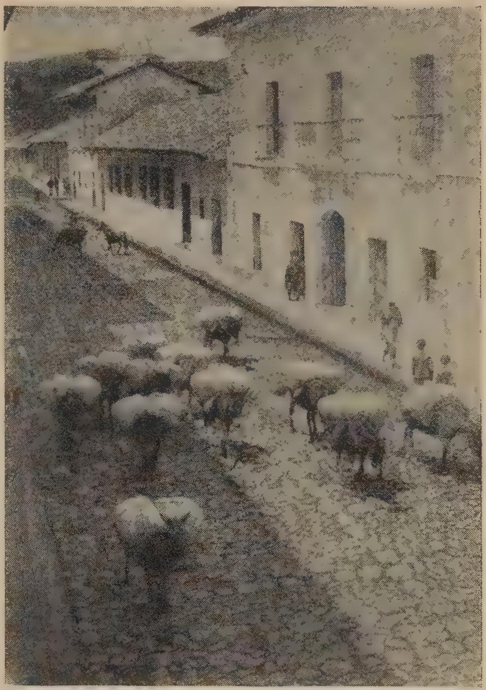

FIGURE 8.—A caravan loaded with coffee leaves for a trip over the mountain roads.

Transportation is the most serious problem in Colombia. The roads which connect small towns with the outside world are wretched at best. During the rainy season travel is absolutely at a standstill; sometimes a road is unusable for two or three consecutive months. Practically no work of repairing is ever done, but the mules must wear their own trails and keep them passable by constant use.

In some sections of the country an effort towards improvement is being made. Between Pamplona and Cúcuta a wagon road is being built, but this is truly one of the poorest pieces of engineering imaginable. No cement is used, but the huge rocks which form the road's basis are thrown together and covered by sand and dirt. Naturally, the first heavy rain washes away the labor of months, and the slow process begins again. What Colombia needs more than anything else is friendly help in this direction, to give the towns some stable connection with the cities, and the cities communication with each other.

Most of the distance from Pamplona to Cúcuta must be covered on a mule, but at the tiny settlement of La Esmeralda there is a railroad which leads into Cúcuta. Concerning railroad structure in Colombia much might also be written, for the same backwardness in engineering methods exists. La Esmeralda is at the base of the mountains; behind arises the huge bulk of the Eastern Cordillera, ahead lie the gentle hills of the lowlands. Up to this point the railroad has progressed rapidly, but here the forbidding mountain wall holds progress at a standstill.

Having reached the railroad, the rest of the way to Cúcuta is comparative luxury. The train rolls steadily down the gradual slope to the city, where a real stone station exists. We have no sooner become accustomed to this magnificence than we are confronted by another—a real street car awaits outside. It consists of two dilapidated coaches drawn by an old Baldwin locomotive, but nevertheless it makes sturdy speed through the streets.

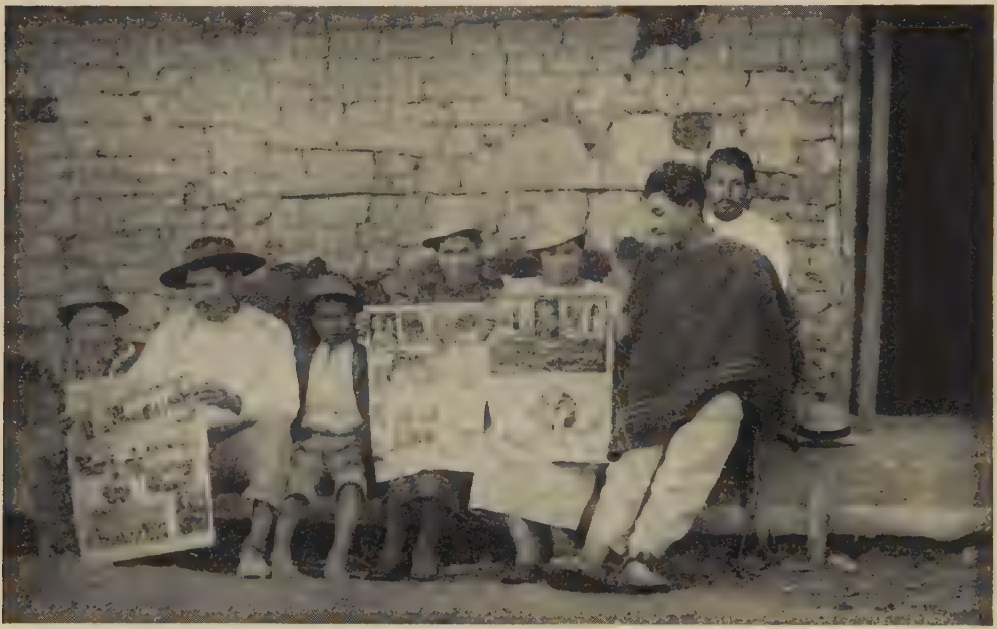

FIGURE 9.—A mountain family enjoys the pictures in an old *New York Times.*

Cúcuta is the capital of its Department, Norte de Santander. It is a new city, built on the site of one which an earthquake destroyed fifty years ago. Its climate is ideal; although it has a low elevation above the sea, mosquitoes are rare, and its weather is always clear and refreshing. After a long stay in the frigid mountain regions, Cúcuta is luxurious.

It is often considered the most beautiful city in Colombia, and among those the writer has seen, it assuredly deserves the title. Its streets are broad and paved, with sidewalks where several pedestrians can walk abreast (a very unusual feature in Latin America). The public buildings are many, and the "Palace de Gobernaçion" is a building which few American cities can surpass in beauty and efficient arrangement. Cúcuta has several excellent hotels which rival each other to make the visitor comfortable.

In addition to these charms, Cúcuta is one of the easiest of inland cities to approach. From it a railroad leads down to a navigable river, the Catatumbo. Here a weekly boat carries passengers across Lake Maracaibo to the city of that name, and, once in Maracaibo, the traveler can reach any port by ocean-going steamers.

Cúcuta is the gateway to Eastern Colombia. It controls an immense and rich region which is cut off from the rest of Colombia by the Andean wall. But, if friendly relations with Venezuela continue, this section will develop rapidly. As trade and travel routes are improved, Cúcuta will receive more business and more visitors, as is the due of its ideal location and its unlimited natural resources.

GLACIAL TOPOGRAPHY AND AGRICULTURE IN CENTRAL MASSACHUSETTS[1]

B. R. Millington

Geographer, Brown University

THIS paper is the result of horticultural studies made in the town of Stow, Massachussetts, in the summers of 1928 and 1929. The region is more or less typical of the drumlin area of the middle eastern part of the State. The reaction of agriculture to physiographic background is about as marked as will be found in any part of the region. This is most clearly exemplified in the neighborhood of Birch Hill, about one mile south of Stow Center and is typified by the farm of "Fruit Acres" and the adjacent lands which were used as a center of operation and observation. In a study of this area, the all-important factor is glaciation with its resultant land forms, most of which are here depositional, rather than erosional in origin.

TOPOGRAPHY

The glacial features of this section play an important rôle in the topography of the region.

GLACIAL FEATURES

The most important topographic feature is the drumlins which constitute the majority of the hills of this region, typified by their shape and lack of rock outcrops. Excavations in these hills show typical glacial boulder-clays and gravels. Marble Hill, one and a half miles northwest of Stow Center, is a marked exception to the drumlin type, since here are to be found several outcrops of granite. This hill is the highest in the area, 481 feet, most of the others being less than 400 feet above sea level. Marble Hill is distinguished from the others by its shape as well as by its height and rock core. It is a true "drumloidal" hill, having the gentle stoss slope, which would be produced if the eroding ice were forced to rise gradually in passing over a resistant obstacle consisting of consolidated materials, and the steep, lee slope which would be produced by plucking on the "down-stream" side of the obstruction. The drumlins, on the other hand, have steeper northern than southern slopes. It seems highly probable that these differences in slope may be attributed to the fact that ice could break through unconsolidated material quite readily and would tend to drag out the loose débris behind those parts of the original obstacle which remained in place. Plucking would be impossible because the material was unconsolidated. Drumlins might be formed in the manner described if a readvance of the ice produced overriding and reworking of an old moraine. In other words, gentle "up-stream" slopes could occur only when the material being overridden was of sufficient resistance to bear the entire weight of the ice and thus force it to rise somewhat in passing over the obstacle. Steep "downstream" slopes could occur only through plucking of large blocks. Erosion of unconsolidated materials by ice could produce neither effect.

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[1] The author wishes to acknowledge the assistance of Mr. H. A. Priest in obtaining field data, and the helpful criticism of the contents of this paper by Professor Bradford Willard and Mr. Duncan Stewart, Jr.

As may be seen from the map (Fig. 1) many of the hills of the region trend northeast-southwest, but the main core of Marble Hill trends northwest-southeast, as do several smaller hills in line with its main axis to the southeast. Apparently this anomaly is due to the fact that Marble Hill was of sufficient height and resistance to deflect eastward a tongue of ice which caused the orientation of the small hills. Probably some of the ice overrode Marble Hill, thus shaping Spindle Hill and most of Birch Hill, lying to the south. The main lobe of ice-shaped Summer Hill, in Maynard, and the southern portion of Birch Hill without being deflected from its northeast-southwest direction. Boon Hill, just south of Birch Hill, trends with the main lobe and nearly at right angles to Birch Hill, indicating that it was between these two hills that the tongue of ice, deflected eastward by Marble Hill, flowed into the main lobe and was absorbed by it.

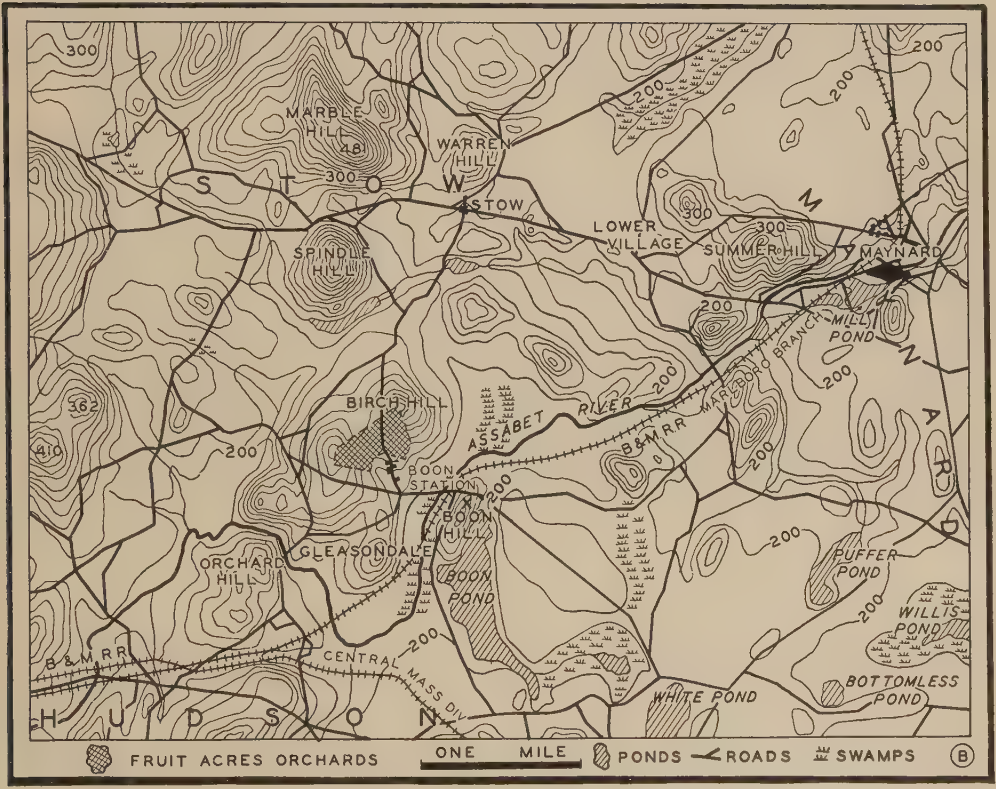
300
MARBLE HILL
448
WARREN HILL
300
S T O W
STOW
LOWER VILLAGE
300
300
SUMMER HILL
MAYNARD
M A Y N A R D
200
200
200
SPINDLE HILL
MILL POND
ASSABET RIVER
MARLBORO BRANCH
B&M.R.R.
362
410
BIRCH HILL
200
BOON STATION
BOON HILL
ORCHARD HILL
GLEASONDALE
BOON POND
PUFFER POND
WILLIS POND
BOTTOMLESS POND
WHITE POND
B.&M.R.R.
CENTRAL MASS. DIV.
H U D S O N
FRUIT ACRES ORCHARDS
ONE MILE
PONDS
ROADS
SWAMPS
B

Figure 1.—Topographic map of the vicinity of Stow, Massachusetts. (From U. S. Topographic Maps.)

GLACIO-FLUVIATILE FEATURES

The Assabet Outlet of glacial Lake Nashua fringes the southern sides of Birch Hill, Summer Hill, and other drumlins similarly situated. Apparently the sediments deposited in the outlet, or in the lake into which it flowed in this region, were built up around the hills to a considerable height above their bases. These deposits have been much eroded by recent stream action, leaving local terraces. Where the present stream has swung close to the hills, steepened slopes have been produced.

Apparently the Assabet Outlet entered glacial Lake Sudbury just east of the town of Hudson in the southwest corner of the accompanying map (Fig. 1). Gradually it built a delta which filled the lake as high as the 220 foot contour and as far northeastward as Boon Hill for, in a large sand pit just west of the crossroads south of "Fruit Acres," the bedding of the sand and gravel dips steeply eastward, as would be expected in a delta deposit built from west to east. In a large pit about a half mile northeast of the northern tip of Boon Hill, the beds lie almost horizontally as if deposited in quieter water. The eastern limit of the delta, therefore, lies somewhere between these two pits. The delta and the quiet-water deposits comprise the sand-plain which extends from the line of drumlins southward to Nobscot Hill in Framingham and eastward beyond Concord.

While the lake was in existence, the present hills rose as islands. As the lake water receded, the stream carried its materials farther eastward before depositing, thus accounting for the presence of coarse, stream-laid sediments on top of finer, quiet-water deposits. Apparently this later series built out along the northern border of the old lake, giving rise to steeply-dipping beds farther eastward to the north of Boon Hill than to the south of it around Boon Pond. The stream continued to build its delta farther out into the lake until its load was decreased, possibly through settling in the basin of Lake Wachuset to the west, when it began to intrench itself in the deltaic deposits in the old lake bed. This channel was gradually deepened and extended eastward and became the present course of Assabet River.

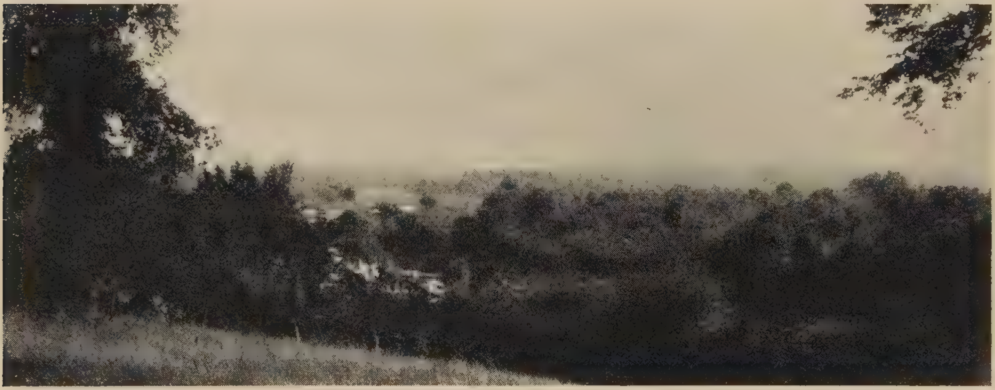

FIGURE 2.—Assabet Outlet looking southwest from the north side of Boon Hill.

Assabet River is a misfit stream. The flood-plain is sometimes a quarter mile in width, while the stream, as between Gleasondale and the outlet of Boon Pond, may be ten feet wide, rather swift, and bordered by

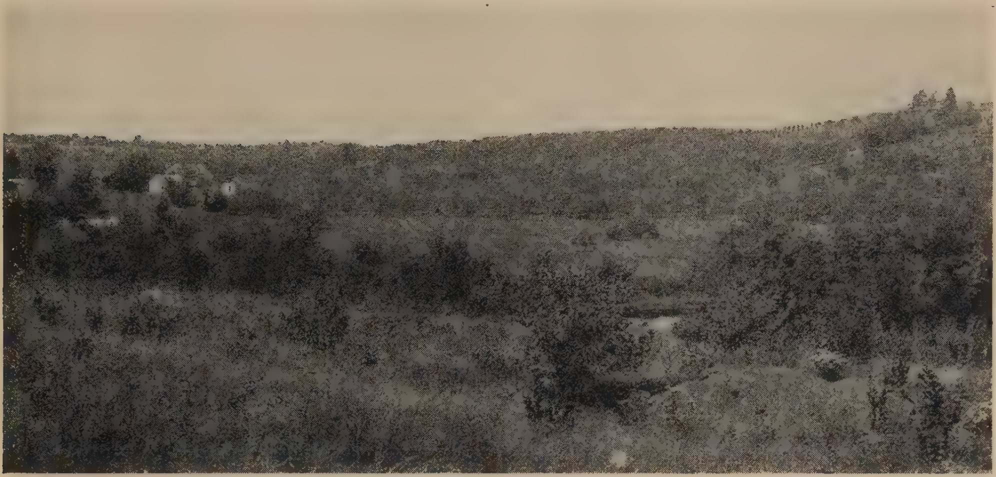

Figure 3.—Southern slope of Birch Hill from Boon Hill, showing Assabet River, lowland, and orchards of "Fruit Acres."

marshland. In some parts of its course, due to flat stretches, the river widens to the full extent of its floodplain, but is so sluggish that, except in flood time, the current is scarcely noticeable. Throughout most of its course, the river is bordered by terraces which range from twenty to thirty feet in height. Where the stream has been constricted by confining ledges, it has cut down to bedrock, producing rapids. Where it has been able to cut laterally unhindered above such rapids, the bed is wider and the water deeper and quieter. The gorge of the stream through the center of Maynard is a good illustration of the narrow portions, and examples of the wider reaches occur between Maynard and Boon Station on the Fitchburg Division of the Boston and Maine Railroad.

Local Topography and Agriculture

The topography is chiefly of importance in its relation to agriculture.

SAND-PLAIN

Throughout most of the area of the sand-plain, especially around Boon Pond, the soil is so sandy that almost the only vegetation that it will support is a thin growth of scrub pine and oak except in the immediate vicinity of the water. Farther east, in Sudbury Meadows and Concord Meadows, occur extensive areas of rich silt-loam deposits which support large truck farms. It is possible that these latter areas were never above lake level during the periods of deposition so that their sediments were fine, while those nearer the borders of the old lake are coarser, probably deposited either in the stream beds proper or as deltas and beaches along the margins of the lake.

DRUMLIN AREA

In the drumlin area are to be found many pockets of alluvial deposits of varying richness, and it is here that much of the general farming is carried on. They support excellent hay and garden crops for several seasons

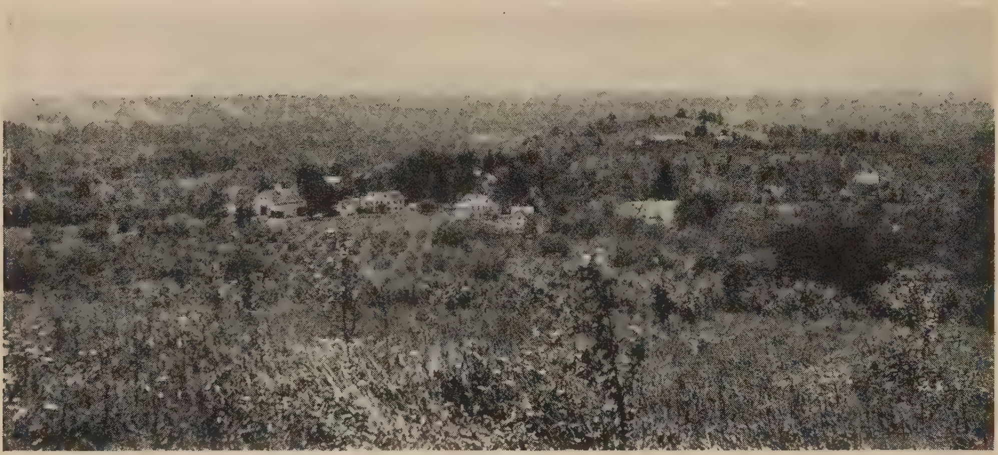

FIGURE 4.—Top of Birch Hill, looking south over "Fruit Acres" across the Assabet Outlet. Young trees show in the foreground on the crown of the hill, and also on the edge of the flat at the foot of the hill. Older trees occupy the slope of the hill but are hidden from view by the shoulder.

without heavy fertilizing, although frequent liming is advantageous. The slight elevations in the area are more easily cultivated because they are drier and firmer than the lowest parts.

It is the hills themselves which play the greatest part in the agricultural development. The soil is chiefly a stony loam, potentially rich in plant foods, well-drained, and yet the water-table is sufficiently high so that trees thrive if properly tended. For this reason, we find either orchards, pastures, or woodlands on the uplands proper, depending upon slope, exposure, and soil. The southern slope of Marble Hill, insofar as noted, is the only southern slope devoted to woodland. Here the slope is too steep for cultivation and only forests can withstand erosion.

"FRUIT ACRES"

Having discussed the area in general, let us now consider our type example, "Fruit Acres." The accompanying photograph (Fig. 3), taken from the point X in Figure 1 on top of Boon Hill and looking north toward the crest of Birch Hill, shows the southern slope of the latter, with most of the orchards of the farm and also some of the adjacent gardens and woodlands. The river, with its narrow border of marsh is nearly hidden by the shoulder of Boon Hill in the foreground, but may be seen between the trees in the center. Across the middle distance the wide lowland, which is possibly three feet above mean stream level at the river, rises gently toward Birch Hill. The lowland is devoted to hay and garden crops with a few apple trees scattered here and there. As the surface rises slightly and drainage improves, the orchards begin, continuing upward to within a few feet of the crest of the hill as a solid block of trees of varying ages. These orchards extend in an almost unbroken mass across the picture and also beyond to the left. The orchards of "Fruit Acres" are shown by broken lines on Figure 1.

The greatest advantage of the southerly and westerly slopes of the hill over the northern and eastern slopes lies in their exposure. The greater insolation of the former slopes permits the trees to start to grow earlier here than on the latter, consequently the fruit in these orchards matures before that of other sections, thus permitting its marketing during the peak of prices, for it is the early fruit which yields the greatest profit. In 1929 the peak of production of Yellow Transparent apples from the Birch Hill orchards was reached nearly five days before the peak for other orchards whose owners also shipped to the Boston market. Consequently, the product of the Birch Hill orchards brought prices much higher than those obtained later in the season for the same variety, inasmuch as a start of a day or two is a distinct advantage because of the highly perishable nature of the fruit as well as the fact that they are the first apples of the season and so eagerly awaited by the restaurants.

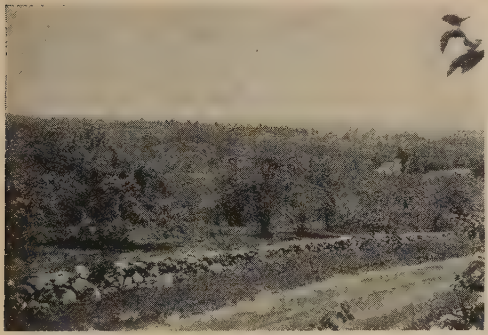

Figure 5.—View from top of a tree half way up the hill, in the Horse Pasture, "Fruit Acres," showing the old Baldwin Orchard in the foreground, with the valley in the middle distance and Nobscot Hill in Framingham rising in the background.

The easterly slope of Birch Hill is very steep and still left to woodland. Whereas the northern slope is partly gentle, most of it is quite steep and is covered with a soil that contains so many boulders as to almost preclude profitable tillage. Its northern exposure has a disadvantage for orchards in that insolation is rather weak at critical seasons, as distinguished from the southern slope conditions. At present, it is used as a reserve pasture and is largely covered by scrub growth and brush.

DEVELOPMENT OF ORCHARDS

Until about 1900, the farms of the area were more or less independent units, each almost completely self-supporting as far as foodstuffs were concerned. The surplus crops were turned into manufactured articles and food luxuries by trading in the neighboring villages. This meant a greatly diversified type of agriculture, with dairying ranking high because of the ready market for milk in Boston. "Fruit Acres" was such a type of farm. Since 1900 there has been a gradual but steady swing toward a general policy of utilizing each type of land to its best advantage. Whereas once garden patches, hay fields, and orchards were located without regard to topography or soil, each crop is now almost always to be found in the places best adapted to it. Orchards are given first consideration as to location because apple-raising is steadily increasing in importance with all other types of agriculture taking minor positions.

When fruit-raising first assumed a commercial scale, the most favorable sections of each farm were set out. Thus at "Fruit Acres" we find the oldest orchards just above the buildings on the first rise of the hill, because here the surface slopes steeply toward the south, and yet is not steep enough to interfere seriously with cultivation. This orchard is far enough above the flats so that in early spring frost drainage is good and the buds protected from damage because the cold air slides down the slope and toward the river without collecting in a thick enough layer to reach the trees. The soil is a stony loam, ideal for trees, and there is sufficient water within reach of the tree roots, due to seepage from the top of the hill. The soil is especially well adapted to orchards; for the stony loam lasts longer than would a finer soil because it takes a considerable time for the tree roots entirely to break down the small cobbles, which are mostly granitic and so rich in plant foods. This means that, although the trees when young need considerable fertilizer, as they grow older they demand proportionately less than would be the case if the soil were finer and the food contained therein more easily digested. It is also easier to control tree growth by food adjustment in a coarse soil than in a fine soil.

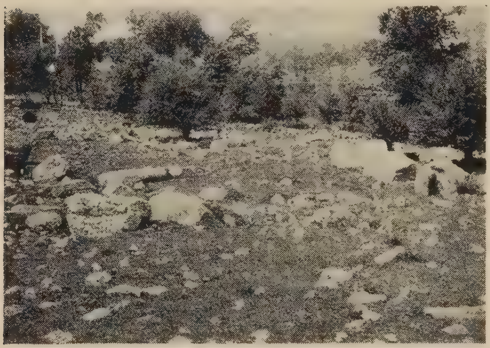

FIGURE 6.—Foot of the north slope of Spindle Hill, showing the rocky pasture in the foreground. In the middle distance, orchards may be seen occupying the gradual southern slope of a small drumlin. The depression between is covered with scrub growth and swamp land.

As the market for the product of this region expanded and transportation facilities improved, further production and larger orchards appeared warranted. The orchards were expanded, first laterally along the hill near the same elevation, then in a parallel belt higher up the hill, and finally below the first belt onto the edges of the sandy deposits along the river terraces. The lowlands, or pockets, throughout the area have been rightly left until last because their soil is so wet and heavy that expensive drains must be installed if the trees are to thrive. Even with drains, young trees are liable to be drowned out in a wet season. Also, it is in these pockets, that the cold air collects as it drains down from the slopes in spring, causing heavier frost damage than in any other part.

SUMMARY AND CONCLUSIONS

The vicinity of the town of Stow, Massachusetts, is a good type example for the discussion of the relation of agriculture to glacial topography. The principal topographic features are the drumlins, the Assabet Outlet of glacial Lake Wachuset, and the sand-plain deposits of the basin of glacial Lake Sudbury.

Whereas formerly, the region was one of diversified agriculture, it is now rapidly becoming an apple-raising district of considerable importance. The change from farming to fruit-raising has been brought about largely by an increase in market demand for fruits and the growing realization by the farmers of the district that their lands are especially well adapted to fruit cultivation. Throughout the drumlin section, we find orchards on most of the southerly slopes because of the climatic advantages of such slopes, while the poor areas and unfavorable exposures are left for woodlands and pastures and are sufficiently extensive to supply the present demands. The sand-plain is still devoted to hay and garden crops because they are still important, although less so than formerly. Thus, due to change in market demands, the region has gradually evolved from diversified farming practiced without regard to the best utilization of the land, to a system under which, insofar as possible, each type of land is devoted to the most profitable crop to which it is favorable.

BOOK REVIEWS

DEPARTMENT OF COMMERCE

Bureau of Foreign and Domestic Commerce

Industrial Structure of New England. By Charles E. Artman. Price, $1.30.

The important elements that form a background for New England's commercial and industrial development are its natural characteristics, including its location; its physical structure and climate; its native resources in soil, forests, minerals, and fisheries; and the number, types, and distribution of its population. These have determined the form and growth of its industry and the extent of its commerce. The topography and climate of the region have influenced the development of a rugged, enterprising, self-reliant population, and have given impetus to specific forms of industrial development.

Much space is given to a detailed presentation of the various manufacturing activities. An introductory section presents a general picture of the nature, importance, diversity, and trends in New England manufacturing as a whole, and its position in the industrial life of the Nation. Analysis is then made of each important line of manufacture.

Ocean Routes in United States Foreign Trade. By A. Lane Cricher. Trade Promotion Series No. 96. Price, 10 cents.

This is a survey of our ocean trade routes to and from foreign countries, and was accomplished after intensive research. It is illustrated throughout with maps and charts.

Inland-Waterway Freight Transportation Lines in the United States. By L. P. Nickell and W. S. Abernathy. Domestic Commerce Series No. 32. Price, 30 cents.

This is the first directory of its kind prepared by this Bureau; however, it is the plan to revise it from time to time as the need justifies. It comprehends all inland waterways in the United States, such as rivers, canals, bays, sounds, and lakes, exclusive of the Great Lakes. It includes a map of the Inland Waterways of the United States.

The Motorization of North Africa. By H. C. Schuette. Trade Information Bulletin No. 689. Price, 10 cents.

There are, naturally, many vital problems incident to the growth of the automotive market in North Africa, such as distribution systems, agencies, financing, and particularly servicing. These and many other questions, as well as pertinent basic economic data, are dealt with in this report, which will undoubtedly be of great interest and benefit to American exporters of automotive products.

The Coffee Industry in Brazil. By Walter Gay McCreery and Mary L. Bynum. Trade Promotion Series No. 92. Price, 20 cents.

An attempt has been made in this bulletin to present a description of the numerous phases of the Brazilian coffee industry; this description, while not unduly technical, is believed to be sufficiently detailed to be of value and interest to those who are engaged in the coffee business.

Markets for Fruit Juices and Fruit Sirups in Continental Europe. By John A. Embry. Trade Information Bulletin No. 683.

In order to find foreign markets for American fruit juices and fruit sirups, a survey was made of the production, use, and foreign trade in those products in European countries. Fruit juices and sirups are at present used to a rather small extent in the countries of Europe, but in most of them their use is increasing. There is a considerable production from domestic fruits, but taking Europe as a whole, there appears to be a possibility of developing a market for imported fruit juices and sirups.

Foreign Trade of the United States, in the Calendar Year 1929. By Grace A. Witherow. Trade Information Bulletin No. 684.

In the geographic distribution of foreign trade the value of exports to those continents taking chiefly finished manufactures showed the greatest increases, and for South America the gain was as high as 12 per cent. Exports to Europe and Asia were slightly less than in 1928 as a result of their smaller purchases of farm products. Imports from each continent increased in value as compared with 1928, the gains for South America, Europe, and Asia being particularly pronounced.

Finland: An Economic Review. By Alvin C. Eichholz and Herbert Rodeck. Trade Information Bulletin No. 681.

This study aims to review the basic economic conditions of Finland in such a way as to give a clear appreciation of the present status and the future possibilities, particularly in their bearing on international trade.

The Price of Silver. By Herbert M. Bratter. Trade Information Bulletin No. 682.

American Underwriting of Foreign Securities in 1929. Trade Information Bulletin No. 688.

German Chemical Developments in 1929. By William T. Daugherty. Trade Information Bulletin No. 690.

European Motion-Picture Industry in 1929. Trade Information Bulletin No. 694.

Airports in Latin America. By J. Warren Engle and Brower V. York. Trade Information Bulletin No. 696.

This bulletin is devoted to airports, landing fields, and weather conditions in Latin America.

The Market for Foodstuffs in Guatemala. By H. P. Macgowan. Trade Information Bulletin No. 678. Price, 5 cents.

Foodstuffs of various kinds to the value of about $4,000,000 are imported annually into Guatemala, and it is estimated that about 90 per cent of the total is supplied by the United States. Some of the principal imports are flour, rice, wheat, canned fruit and vegetables, crackers and biscuits, packing-house products, dairy products, and dried fruit. There is only a small market for some of these products, but the demand for others is increasing.

The Marketing of Nickel. By J. W. Furness. Trade Information Bulletin No. 685. Price, 10 cents.

Throughout the world the industrial nations have, during the past few years, required ever-increasing amounts of alloys. So rapid, indeed, has been the increase in demand as to presage the dawn of an alloy age.

The part played by nickel in this development is a most important one, in that nickel when alloyed with iron and carbon, as well as chromium, tungsten, vanadium, molybdenum, cobalt, etc., imports to the resultant product physical properties that cannot be duplicated in their entirety by the use of any other metal; various combinations of nickel and copper possess great resistance to corrosion and erosion, thus prolonging manyfold the usual life of the material.

At present the world's consumption of metallic nickel approximates 40,000 tons a year. The increase since 1923 (when consumption was about 31,000 short tons) shows what can be accomplished by intensive research work directed along the lines of collecting and disseminating information on the properties of metals, investigating the rational and economic scope of their industrial application, and searching for possible new uses. Not only has this policy, carried out by individual organizations, been remunerative to the industry as a whole, but it has brought about a better understanding of the many uses to which nickel may be applied.

Installment Selling of Automobiles in Oceania, Asia, and Africa. Trade Information Bulletin No. 686.

The value of United States automotive exports during 1929 to Oceania was $56,548,958, to Asia $61,897,739, and to Africa $30,562,115, a total of $149,008,812 and an increase of nearly 15 per cent over the total of $129,816,000 for 1928. In those continents the American vehicle predominates, accounting for nearly four-fifths of total registrations in both Oceania and Asia and approximately two-thirds in Africa.

Markets for Sawmill and Woodworking Machinery in South America. By Charles H. Ducoté. Trade Information Bulletin No. 687.

The countries of South America present widely varying markets for sawmill and woodworking machinery. Some factors, however, are common to all. Hand labor is generally rather cheap; sawmill and woodworking industries are characterized by many small units requiring comparatively simple machinery; and, wherever any important demand for machinery exists, considerable competition is encountered from European manufacturers.

Several South American countries are richly endowed with forests; but the timber is so inaccessible or so widely scattered in many cases that it cannot be exploited commercially except with great difficulty; and much lumber is imported. That condition restricts the market for high-grade sawmill machinery, and the smaller portable mills are fairly numerous. In Argentina there is an exceptional opportunity in connection with the quebracho industry, in which an attempt is being made to use scientific methods and modern machinery.

This bulletin describes in some detail the sawmill and woodworking industries of the various countries of South America, the type and origin of the machinery now in use, and gives suggestions as to the best methods to secure new business, with the purpose of giving the United States exporter a practical idea of the present situation.

Markets for Sawmill and Woodworking Machinery in Scandinavia and the Baltic States. By T. O. Klath. Trade Information Bulletin No. 691.

With the exception of Denmark, the Scandinavian countries and the Baltic States are characterized by extensive forest areas. These have given rise to sawmill and woodworking industries which in most of the countries are very important, if not the most important, activities. Hand labor is commonly used in the Baltic States, but in the other countries the sawmill and woodworking industries are rather highly developed and there is a correspondingly active market for high-grade sawmill and woodworking machinery.

While the market is highly competitive, it is believed that sales of American plywood machinery can be increased steadily, and that there is room for expansion in other lines. To assist in accomplishing such results, this bulletin describes the sawmill and woodworking activities in the various Scandinavian and Baltic countries, outlines the methods now being followed, shows the various types and origin of the machinery in use, and gives practical hints as to the best way to expand old and secure new business.

Salvador as a Market for Foodstuffs. By H. P. Macgowan. Trade Information Bulletin No. 692.

Salvador spends annually nearly $2,500,000 for imported foodstuffs, about 72 per cent of which is expended in the United States. Most of these food products are shipped from our Pacific coast ports, but the opening of rail communication with the Caribbean through the Guatemalan port of Puerto Barrios is expected to alter the situation. American exporters who ship through Atlantic and Gulf ports now have a better opportunity to enter the Salvadorean market than at any time in the past. European shippers will also be able to take advantage of this shorter haul, however, and the indications are that competition will become keener than ever.

Flour, lard, hams, canned meats, canned fruits and vegetables, sardines, fresh and dried fruit, fresh and dried vegetables, crackers, canned milk, butter, and cheese are among the more important items shipped from the United States to Salvador.

Though economic conditions in Salvador are at present unsatisfactory as a result of the current weakness in the price of coffee, the commodity which accounts for over 90 per cent of the country's exports, this is a good time for firms contemplating future extension of distribution to Central America to survey the market, estimate the potential demand for their products, and arrange for sales representation.

Fruit Markets in Eastern Asia. A joint investigation by the United States Department of Commerce and the University of California.

While the investigation confirms what we already know in regard to the situation, it is of value because of the thorough method by which it was carried out and should help to definitely settle many questions that have been raised in regard to the possibilities of a wider market in the Orient.

The conclusions indicate clearly the limits of the present market; they also point out that further expansion is largely dependent on the development of greater purchasing power and higher standards of living for the masses of the Orient. Many believe that this will come slowly and that it promises a potential market some time in the future. If this is true, it justifies careful planning and study of the food habits in the Far East and careful watching on the part of exporters for changes in standards of living, changes in food habits, and the development of greater purchasing power.

Railways of South America, Part III: Chile. By W. Rodney Long. Trade Promotion Series No. 93. Price, $1.30.

This monograph presents detailed information with respect to all the railways of Chile, covering such phases as the development, mileage, operating officials, methods of purchase, finances, traffic statistics, characteristics of right of way, number of employees, motive power, rolling stock, repair shops, and equipment, as well as an analysis of the railway supply market.

The report was prepared by W. Rodney Long, of the Transportation Division of the Bureau of Foreign and Domestic Commerce, through the coöperation of various locomotive and car building companies, manufacturers of railway equipment, exporters of crossties, and other interested companies, with the Transportation Division, the Machinery Division, the Iron and Steel Division, and the Electrical Division of the Bureau.

This is the fifth of a series of reports on railways in Latin American countries. Preceding numbers, all issued in the Trade Promotion Series, are as follows:

No. 5	Railways of Central America and West Indies.
No. 16	Railways in Mexico.
No. 32	Railways of South America: Part I, Argentina.
No. 39	Railways of South America: Part II, Bolivia, Colombia, Ecuador, Guianas, Paraguay, Peru, Uruguay, Venezuela.

The sixth and last volume in this series, covering Brazil, will appear in the near future.

Chain-Store Developments in Great Britain. By Ralph S. Charles. Trade Information Bulletin No. 697.

International Trade in Mica. By Joseph Ulmer. Trade Promotion Series No. 95. Price, 15 cents.

National Retail Credit Survey, Part I. Domestic Commerce Series No. 33. Price, 10 cents.

Preparing Shipments to Canada, Documentation and Customs Entry. Trade Promotion Series No. 91. Price, 10 cents.

Employment for Americans in Latin America. Fifth Edition.

Discussion of the limited opportunities for employment of Americans in Latin American countries.

Index to Commerce Reports, Nos. 1–13, Volume I, Thirty-third Year, January–March, 1930. Single copies, 5 cents; annual subscription, 20 cents.

This index is issued quarterly and lists all material published in Commerce Reports by subject, country, and author.

U. S. COAST AND GEODETIC SURVEY

Hydrography. Slope Corrections for Echo Soundings. By A. L. Shalowitz. Special Publication No. 165. Price, 10 cents.

Description of method used in taking depth soundings for ocean surveys.

Seismology. Progress of Seismological Investigations in United States, July 1, 1927, to January 1, 1930. By N. H. Heck. Special Publication No. 167. Price, 5 cents.

This report on earthquakes was made to the section of seismology of the International Geodetic and Geophysical Union of the International Research Council.

BUREAU OF THE CENSUS

Manufactures. Census of Manufactures, 1927. Summary by Industry Groups and by Industries. Price, 10 cents.

HELEN M. STRONG.

Pack, Charles Lathrop, and Gill, Tom. *Forests and Mankind.* x and 248 pp.; bibliography. Macmillan Company, New York, 1929.

During the last twenty years the notion of forestry had acquired a great popular appeal. A persistent and skillfully directed program of public education, carried on through the press, through civic organizations, and by other means, has gained for forestry a widespread interest and a considerable degree of popular approval. Despite this, by a surprisingly large number of laymen, including some ardent conservationists, the scope and aim of forestry is misunderstood. Many confuse forestry with forest conservation, others with artificial reforestation.

Forests and Mankind is a story of forestry, its objectives and practice, written in the interest of furthering popular belief in forestry and an understanding of its problems and aims. It acquaints the layman, who may be an advocate of forestry on the ground of conservation, with the fact that it is concerned with the use, as well as the saving, of the forest; with harvesting trees as well as planting them; that forestry is the business of producing crops of forest products, just as agriculture involves the production of crops of other sorts.

The authors begin with a short discussion of the physiology of the tree, from which they proceed to a consideration of the relationships of and within communities of trees, giving some notion of forest ecology. The geographic distribution of forests and forest types of former ages, the dynamism of forest communities, and their environmental modification during countless ages, leads to the consideration of present forest distribution, particularly in the United States.

The remainder of the book is concerned with forestry, its definition, its application in the United States, and its many ramifications. A chapter describes the system of National Forests, others describe the various products of the forest, and one touches the relation of forests to wild life.

The problems of fire protection, insect control and eradication, and waste in utilization are given merited attention. Forestry in its relation to agriculture and its application in farm economy and the future of industrial forestry are treated at some length. The authors conclude with a statement of the inevitable need for forestry, and a plea for its hasty inception, in order to avoid national forest bankruptcy. The book is non-technical, interestingly written, and excellently illustrated.

CARLETON P. BARNES.

Yoder, F. R. *Introduction to Agricultural Economics.* xix and 472 pp. Thomas Y. Crowell Co., New York, 1929.

For the specific purpose that the author intended it—*i.e.*, to serve as "an introduction to the subject for beginning students" and to lay down the elementary principles of economics, the *Introduction to Agricultural Economics* seems, on the whole, a well-planned and well-executed piece of work. To eliminate debatable and borderline elements is a highly commendable practice for an introductory exposition of the subject. His differentiation between agricultural economics and farm managements tends to further clarify the purpose and scope of the respective subjects. He writes that "Farm management is concerned with the principles governing the successful and profitable operation of the farm from the point of view of the individual owner or operator. Agricultural economics is concerned with the economic principles underlying agriculture as an industry."

After the introductory chapter dealing with a history of American agriculture and agricultural economics, which constitutes an adequate orientation for the immature student, the author endeavors to depict the present rural situation as soon as the subject has been defined, the field delineated, and certain basic conceptions postulated.

A discussion of the constituent elements of the field follow in logical sequence: Land as a Factor in Agricultural Production, Land Income and Land Value, Land Tenure and Land Policies, Social Capital, Credit, Insurance, Loans, Farm Management, Marketing, Foreign Markets, The Tariff, Taxation, and Farmer Movements.

The treatment of the subject throughout most of the chapters is elementary, but necessarily so in view of the student's usual previous preparation. The chronological method of approach employed in certain chapters is interesting and effective. Portions of the chapters on Price Economy, Land Income and Land Values, Foreign Markets and Farm Taxes should prove stimulating to the neophyte. The inclusion of information relative to the recent formation of additional credit institutions serving the farmer is timely and suggestive.

Certain chapters dealing with the elimination of the middleman, government price fixing of agricultural products, and the effectiveness or ineffectiveness of the tariff might well be read by the farming population as a whole. To strike out blindly against all middlemen and to denounce by the use of blanket statements all of their activities is to display an ignorance of elementary economics and a decided lack of judgment. There are certain functions undertaken by the middleman that can be performed most economically by him and the author recognizes the services rendered by the great coöperative associations like the California Fruit Growers' Exchange, which sells through the wholesaler and retailer to the consuming public.

In a distinctly lucid and simple way, the matter of Price Fixing is presented. A number of agricultural writers, inspired more by the ethics of the situation than by the economics of it, would have the government allow the farmer a certain profit above production costs; and thus would have the government on this basis make up deficits that might occur.

But how are production costs, the basic figures needed for the calculations and subsequent reimbursements, to be arrived at? The determination of these figures would be a simple matter if all farmers expended the same amount of time, labor, and capital, per unit of goods produced. But the latter situation is not the true state of affairs. An extremely variable factor, the human one, must be recognized. From current farm management surveys, the writer observes that the costs of producing wheat by farmers in different sections of the country range from 75 cents to four dollars per bushel; that of producing cotton ranges from ten cents to fifty cents per pound. The efficiency and ability of farm management varies with individuals; the cost of labor, land, rent, and interest rates vary with the locality, hence the difficulty of computing such a complex and variable figure. He also notes that "if the higher costs were taken, then price guarantees would encourage the inefficient farmer to continue production, acreage would be increased among the better farmers and the price would be further depressed."

A salient feature of this book is the clean-cut distinction drawn between effective and non-effective tariffs from the standpoint of farmers and other groups.

The normal consequences of the general enlightenment of the farmer and layman on the matter of the tariff would be far reaching in their significance. These results, no doubt, would include new political alignments and an increased pressure on Congress; they might even embody such visionary benefits as adequate constructive legislation and an improved economic status.

N. C. BURHANS.

Büsgen, M., and Münch, E. *The Structure and Life of Forest Trees.* Third, Revised and Enlarged Edition. xi and 414 pp.; index; illustrations. John Wiley and Sons, New York, 1929.

The translation of this excellent text in tree anatomy and physiology provides a comprehensive reference work that has not been adequately supplied by any work in English. The subject has, of course, received treatment in the literature of silviculture, wood technology, and plant physiology, but such treatment has ordinarily been supplementary or adjunctive to the main theme. Here, however, we have an entire volume devoted expressly to the study of the life processes and morphology of forest trees.

While not primarily ecological, the work deals extensively with the effect of environmental influences on the form and functional activities of the tree.

Dr. Münch, who has revised and edited Büsgen's original text, has devoted a chapter to the formation of "morphological local races," resulting from environmental influence. His statements regarding the inheritance of crookedness of bole suggest a belief in the hereditary transmission of acquired characteristics. His contention regarding the effect of heavy snow on crown form may seem valid on the basis of examples drawn from European forests, but there are North American trees (Bristlecone fir) that seem to refute it.

Dr. Münch advances a theory of the circulation of sap somewhat different than that generally held by plant physiologists.

The illustrations add immeasurably to the usefulness of the work. Both well-chosen photographs and unusually fine pen-and-ink drawings serve to enhance its value as a text. The chapter on "The Form of the Tree" has particularly noteworthy illustrations from the authors' experience and the exemplification of nearly every principle are pleasing features.

The specific examples, although drawn largely from European experience, are such that application can be readily made to North American genera. There is indicated an acquaintance with North American forest flora.

CARLETON P. BARNES.

Davis, Joseph Stancliffe. *The Farm Export Debenture Plan.* Miscellaneous Publication No. 5 of the Food Research Institute, Stanford University, California, October 12, 1929. x and 265 pages.

When Thomas Malthus formulated his dismal concept of population, it was predicated upon the ultimate pressure of population on the food supply. Today, in the United States, we are confronted by the means of subsistence pressing upon population, and the Congress is called upon to struggle with a surplus of food. The producer of this surplus asks for legislative aid in restoring and maintaining his purchasing power on a parity with that of producers in other fields. Since foodstuffs constitute by all odds the major product of agriculture and animal husbandry, food problems are thus in considerable part agricultural problems. The American farmer then is seeking to improve his own position by insuring the disposal of the entire crop at a figure commensurate with its cost of production.

The persistence of unsatisfactory conditions among farmers since the War has given rise to a number of plans for "farm relief." Chief among these legislative aids to the farmer has been the Export Debenture plan which came prominently to public attention in the spring of 1929. "Although not a part of the Agricultural Marketing Act of June 14, 1929, the debenture plan may be expected to reappear, in one form or another, until it is either adopted or finally rejected."

Under these conditions an analysis of the proposal is of more than academic interest.

In this publication of the Food Institute the author has produced a thoroughly readable study that is "not merely an exposition and analysis of the export debenture plan, but as well comprehends an interpretation of the agricultural situation, some appraisal of the grounds for farm relief of various sorts, and a consideration of many arguments that apply to the several types of proposals." Although this plan is commonly regarded as applicable to any farm product and manufactures thereof, of which we do or may produce an export surplus, the author has dealt mainly with wheat.

"The export debenture plan is avowedly a price-elevation scheme, since practical difficulties seem to preclude the possibility of curtailing production. It seeks to raise farm prices of agricultural products of which the United States produces export surpluses, and to raise domestic prices above export prices of these products." As in the case of the McNary-Haugen plan with its equalization fee, it is predicated upon the low purchasing power of farm products as the major cause of agricultural difficulties. While prices of farm products and prices in general have been higher than before the War, the advance has been much less in farm prices than in prices of goods and services that farmers must buy. It is assumed that the United States is definitely committed to a protective tariff policy; this plan "seeks to make the tariff effective" on these farm products, at least in part, by establishing domestic farm prices on a higher level than would otherwise be the case. It is implied that the prices of other farm products would rise also, thus increasing the farmer's income. It is then the farmer who is to be aided, not agriculture.

The writer feels that as a measure for surplus-control the export debenture plan has its serious shortcomings, due in large part to the inelasticity of the plan for controlling surpluses of varying amounts. In practice, he feels that it would fail to yield the promised advantages. Like the equalization fee, this plan seeks to effect a redistribution of national income in favor of the farmer, although it does not, in his opinion, partake of the nature of a subsidy to the farmer. This issuing of debentures to export merchants and their redemption in payment of import duties is preferable to a cash subsidy on legal, administrative, and psychological grounds.

In the succeeding chapters the author goes into some detail to present the case for the export debenture plan, its sources of support, the prospective cost and permanence of the plan, the probable effect its adoption would have on farm prices and on the acreage of certain crops, and the experiences of other countries with a somewhat comparable scheme, respectively. There is throughout the very evident desire on the part of the writer to do justice to all phases of the problem. It is, as he says, an ingenious and exceedingly plausible plan for farm relief. Its similarity to the protective tariff in particular he seeks to establish is not at all what proponents of the debenture plan assert. In this instance he points out that a protective tariff has been regarded as a means of fostering undeveloped industries or of maintaining those which are unable to supply the domestic market in the face of foreign competition; whereas the debenture plan is addressed to well-developed agricultural export industries only. That, however, is not to be construed as a defense of the tariff.

"The major test of the operation of the scheme would come after the first year of its operation, when the adoption of the price raising plan would have time to exert influence on acreage, production, and exports of the debenturable products. There is every reason to expect fairly prompt, definite, and substantial increases under the natural stimulus afforded by the measure, except in those cases where none of the product enters into export trade. The result of increased output and exports would be to cause recessions in prices abroad and export prices here, so that, even though domestic prices were kept above normal export parity, the net increase in prices would be greatly reduced if not eliminated." So far as farmers are concerned, the benefits in a few years would have vanished, in large part or entirely, and with them the burdens upon the consuming public. On the other hand the Treasury burden would be materially larger, in consequence of the enlarged exports, and the justification for this burden, in genuine benefits to farmers, would have largely disappeared. Upon the debenturability of the product would depend the rate at which this would take place. "As it now stands, the consideration of this debenture plan must be taken in the light of the present Federal Farm Board, to which it is less a supplement than it is a contrasting alternative." It is possible that this plan or some modification of it may in time have genuine merit, but just now it is the opinion of the author that to pursue farm relief up this path would be to court disaster.

ALFRED J. WRIGHT.

Rumma, J., Grano, J. G., and Veski, J. V., editors. *Eesti. Kodu-uurimise töö.* (Estonia. A study of home.)

I. Tartumaa. 1925: 140 pp., 20 maps.—The work is a cyclopedical study of the geography, economics, and history of the Province of Tartu, Estonia, based upon archaeological findings, documents in archives, published sources, and original investigations. The material is divided into two main sections: general and special. The general section dealing with the Province as a whole is subdivided under the following four headings: location, statistics, nature, and man. The subsection on nature consists of the following chapters: geological formations, surface forms, their development, climate, waters, flora, fauna, and landscapes; and the subsection on man: habitations, inhabited places, ways of communication, economic conditions, intellectual and spiritual life, hygienic conditions, history, education, language, and ancient history. In the special section, for the units of study, parishes, towns, and cities are taken. The material in each chapter is classified under the same headings as in the general section. The work gives a comprehensive picture of the past and present of the Province, with emphasis on the city of Tartu as the Provincial seat and the center of higher learning in Estonia. In the chapters on parishes, of special interest are the histories of the large landed estates (feudal latifundias) formed centuries ago and having lasted up to the independence of Estonia. The geological descriptions appear to be done with much detail and with painstaking care. Scientific methods are applied. The historical events are described and analyzed from a strictly objective point of view. The editors and contributors are largely faculty members of the Estonian University at Tartu.

II. Võrumaa. (Province of Võru.) 1926: 497 pp., 10 maps.—The same arrangement of material and the same methods are used as in Part I. In this volume the chapter on provincial history commands closer attention. The Province of Võru was the southeastern corner of Estonia up to 1920. As a boundary province it was the scene of constant three-cornered conflicts and wars. The native Estonians fought both invaders, Germans and Russians; Germans fought Estonians and Russians; and the Russians, in their turn, fought Estonians and Germans up to the last war in 1919, which was again a three-cornered struggle between the same opponents.

III. Setumaa. (Province of Setu.) 1928: 381 pp., 5 maps.—The material is presented in the same manner as in Parts I and II, except that instead of being divided into parishes as units of study, the Province is divided into four areas on the basis of common geographical features. The description of a considerable group of people inhabiting the Province, called Setu, and numbering over 15,000, is of special interest. These Setu are ancient Estonians. They were incorporated into the Russian Province, Pskov, and were part of it for over seven centuries. The attempts to Russianize them failed. They were christianized into the Greek Orthodox faith; but, as the Russian priests did not speak Estonian and the Setu could not understand Russian, the influence of Christianity upon the Setu was so superficial that they continued to worship their pagan idol, Peku, in their homes practically up to our day. Although the Setu took over from the Russian a number of words and changed certain vowels, yet they have preserved the forms and pronunciation of the ancient Estonian language to a much larger extent than the modern Estonians themselves.

PETER A. SPEEK.

Loomis Havemeyer. *Ethnography.* iv and 522 pages, 225 illustrations, 3 maps, bibliography and index. Ginn and Company, Boston, Mass., 1929.

G. Elliot Smith. *Human History.* xi and 472 pages, 67 illustrations, bibliography and index. W. W. Norton and Company, New York, N. Y., 1930.

The human geographer will welcome these volumes as source material for the study of man. Although neither is written from a geographical standpoint, much of the material deals with environmental influences. This is particularly the case with Dr. Havemeyer's book on primitive man. *Ethnography* is not a systematic treatise, but rather a collection of quotations skillfully woven together and designed to serve as supplementary reading in a college course. The book deals with a few tribes in each of the main races and in each case discusses the conditions of environment, racial characteristics, self maintenance, perpetuation and gratification, religion, and regulative organization. The major emphasis is on the social life of the people. Twenty tribes or peoples are described in all, of whom eleven belong to the black race, two to the brown race, four to the red race, two to the yellow race, and one to the white race.

Human History also deals with primitive society but treats it from the developmental standpoint. This book is an account of man's history from earliest prehistoric times to "the glory that was Greece." Opening chapters deal with the wanderings and industries of our early ancestors and are followed by a consideration of the races of mankind, and of the characteristics of primitive man, which the author holds to be gentle and quite un-"savage." The beginnings and rise of civilization occupy about half of the book, with material on Egypt, Crete, Greece, and other countries. Dr. Smith has attempted to cover both the natural history and the social activities of man. Such an attempt to bridge the unfortunate gap between science and the humanities is commendable, and anthropologists will doubtless agree that Dr. Smith has made a real contribution toward this end.

GEORGE B. CRESSEY.

Alcaraz, Eurique. *Climatologia Agricola.* Two volumes. Volume I, 217 pages, 26 diagrams and tables, 22 maps, index. Volume II, 374 pages, 13 diagrams, 90 tables, 14 maps, appendix, and index. Madrid, 1925.

Mr. Alcaraz, professor in the Special School of Agricultural Engineering at Madrid, has presented in the *Climatologia Agricola* a good summary of weather and climate and has emphasized the biological life in Spain in relation to climate.

The general plan of the work consists of three parts. The first division, Volume I, includes a geographical résumé of the distribution of the land and the seas of the earth and continental relief. It also contains a discussion of the general geographical distribution of insolation, temperature, pressure, winds, ocean currents, humidity, cloudiness, precipitation, soils, biological forms, and human activities and their relations. The first nine chapters are devoted to general laws of meteorology and climatology, and the division of the earth into climatic zones thus preparing the reader for the agricultural and natural life discussions which follow.

Chapter X is devoted to the formation and the distribution of soils in relation to climate. He divides the soils into the following formations: laterites, desert, sub-desert, vegetal (black earth and loess), humic (acid soils and podsol), tundra, and turbosa. General characteristics and the distribution of each are briefly discussed.

In Chapter XI, the relation of exterior conditions especially upon animal and plant life is treated as biogeography. He groups the plants into tree, liana, herb, and epiphytic divisions and classifies the animals according to those which live in and on the earth, in the air and in water. A summary of the classifications by eminent biologists is included.

Chapter XII is a general summary of the relation of animals and plants to climate and soils. Volume I includes 22 maps, six of which represent rather inaccurately the relief of the continents; the others show the distribution of isotherms, isobars, winds, ocean currents, paths of cyclones, and anticyclones.

Volume II contains the second and third parts of this work. The second part, "Climatologia Descriptiva," gives the general classification of climates, physical characteristics, biologically and agriculturally. The author briefly describes and classifies the climate as follows:

- *With wet periods*
  - Hot without dry periods—equatorial
  - Hot with dry periods—tropical
  - Temperate without cold periods—subtropical
  - Temperate with cold periods—temperate
  - Cold with periods of moderate warmth—frigid
- *Without wet periods*
  - Hot without cold periods—deserts
  - Temperate with cold periods—fell type
  - Cold without temperate periods—tundra or arctic

The world vegetation is divided into zones and geographical regions are given for each. The zones are as follows: Arctic, northern forests, northern steppes, Mediterranean, Chinese-Japanese, Sahara, tropical, southern steppes, southern El Cabo and Chile, southern forests, Australia, Madagascar, and Oceania.

The zoological regions are as follows: Palearctic, including the frigid and temperate zones of the old continents; Nearctic, comprises the frigid and temperate zones of the new continents; Oriental, comprises the hot zones which are affected by the monsoons; Etiopica, extends through all of equatorial Africa and tropics influenced by warm, humid climates; Neotropical, extends from Central America and south where the climates are hot with humid periods; Australian, includes nearly all of Oceania influenced by hot, temperate and dry climates.

Chapters II to V contain descriptions of the flora and fauna as classified and include the principal families and genera. The discussions dealing with climate contain many tables showing temperature and precipitation at various stations in each region. A brief summary of agricultural conditions is included with each climatic region.

Part three, "Climatologia Iberica," nine chapters, contains a good description of the climate of the Iberican peninsula. The writer divides the country into physiographic and climatic divisions and discusses the meteorological influences affecting the climate. The two climatic groups are given as (1) those influenced by the Atlantic: maritime, transition, and continental; (2) those influenced by the Mediterranean: maritime and continental. Tables showing the precipitation, humidity, and temperature are given for each region. The relation of climate to plants, agriculture, and animals are discussed in each region. This part of the work is most complete and makes a good reference on Spain.

Thirteen colored maps show the climatic regions of the continents and countries discussed in the text. However, the keys to the colors of the maps are on separate pages and hence are not as usable as they should be. The author seems to make no reference to the maps in his textual material and hence they do not appear very valuable. Some of his diagrams are so small that the print cannot be read with ease. Although the title of the book is "Climatologia Agricola," the author gives very little emphasis to agriculture. The work, however, contains much valuable data and is a good reference written in Spanish. It is particularly valuable for the material on the Spanish peninsula.

ESTHER S. ANDERSON.

Agar, Flint, and Longwell. *Geology from Original Sources.* xxi and 527 pp., 70 plates, and 16 text figures. Henry Holt and Company, New York, 1929.

The authors at the outset state clearly that this volume is not a textbook in geology; that its mission is to furnish such supplementary material that the young student will come to realize early the significance of the subject as something of human development. Their purpose in this respect appears highly commendable. Human Geography has intrenched itself as a popular and worthwhile subject. Why should not geology likewise present its human aspects?

The book is an orderly compilation of authentic, interesting articles arranged so as to bear specifically upon the phases usually treated under Physical Geology. Their arrangement is not that of any rigid sequence; readings can be selected to fit the scheme of instruction which may be based on any of the standard texts. The lack of rigid sequence adds to the elasticity of the work as a reference book and thereby widens its potential usefulness. Fourteen groups of readings are listed as chapters, beginning with "Minerals and Rocks"; "Climate, Weathering and Soils"; and continuing with "Streams and Valleys"; "Glaciers and Glaciation"; "Ground Water"; "Lakes and Swamps"; "Shorelines"; "Sediments and Sedimentary Rocks"; "Volcanoes and Volcanism"; "Movements of the Earth's Crust"; "Metamorphism"; "Land Forms"; "Geology in Modern Life"; and "The Scope and Method of Geology."

The titles of the chapters suggest the diversity of readings presented but they do not give much indication of the richness of the contents. All agree that wide reading in connection with college studies is essential to true understanding and to the development of culture, but in most cases beginning classes are too large and library facilities are too meager to make this procedure feasible. Here, however, the works of the masters of the science are presented, selections from some of the notable pioneers in the field are placed within reach side by side with those of modern scholars. Readings from Dana, Huxley, Lyell, Geikie, I. C. Russell, Gilbert, and Powell are presented as classics, as are also some of the best-known writings of later workers ranging from W. M. Davis, Chamberlin, Penck, to those of Huntington, Bowman, and Johnson. Therein is the real contribution; the student is led early into some acquaintance with the original works in the field of geology, a goal worthy of unstinted commendation.

NELS A. BENGTSON.

Jones, Clarence F. *South America.* x and 798 pp.; maps, charts, tables, and pictures. Henry Holt and Company, New York, 1930. 9½ x 5½ inches. Illustrated, $6.00. Students' Edition, $4.75.

This volume represents a detailed and practical treatment of the geography of South America. It is a notable contribution to the geography of South America and fulfills a marked need in the teaching profession. No textbook, in the field of geography, that has come from the press during the past decade has been more desirable than this volume, especially to colleges and universities that offer courses on the geography of South America.

The author's many months of travel in South America and his years of research have made him one of the leading authorities on the geography of that great continent. He has written a thorough-going and scholarly textbook, based upon accurate first-hand information. The book should be very attractive to the students of geography and also to capitalists and commercial men, as the discussion embraces the major topics that might be of interest to the American business man.

South America is organized primarily on a regional basis. The first chapter presents a brief picture of South America through the centuries from the time of Pizarro through years of its development up to the present economic penetration of foreign capital and men.

Chapters II to VI inclusive treat in some detail the general aspects of physiography, climate, natural vegetation, transportation, and the people and their major problems.

In the regional chapters the author begins with a treatment of the Falkland Islands. Though less significant and less South American than most any other portion of the continent, these islands provide a unique and logical way of opening the discussion because of their geographic and economic simplicity. Throughout the regional chapters emphasis is placed upon physical factors and the economic adjustments to these factors. Though the volume is largely a regional geography, the identity of the several republics has been maintained. For each of the large republics a chapter introduces the country and gives in some detail the historical background so important in all South American countries.

The book is illustrated with 334 pictures and maps. Sixty per cent of the pictures are from the author's own camera. The black and white distribution maps and the regional map in the back of the book are distinct contributions to the literature of the continent.

From the teaching standpoint the book is excellently put together. It consists of 50 well-organized chapters, with an average length of pages. The style is free and lively, but not overdone. There is a splendid well-selected bibliography of more than 40 pages. The index is an unusually valuable one for the teacher because of the organization and details of it. In addition, the print is of good size. This book should be, for a long time, the standard textbook on the geography of South America.

The book is a handsome well-bound volume. The publishers are to be congratulated upon the appearance and general make-up of the book.

HARLEY P. MILSTEAD.

Editorial Staff of the Committee on the Study of the City. *Tartu.* 728 pp., 1927.

An Estonian cyclopedical study of the history, geography, and economic and social conditions of the city of Tartu in Estonia, by a staff of editors and collaborators invited and appointed by the city government, principally from the faculty members of the Estonian University of Tartu, and published by the city government. To the volume are added 17 separate maps, plans, and statistical tables. There are also numerous photographic illustrations and charts in the text. To the titles, subtitles, and terms used in the text are added French translations, and to the entire work is added a summary of 78 pages in French.

The work contains informative data, with interpretation, in regard to the city of Tartu as a whole. It is divided into three main parts:

A. History—6 chapters by 3 authors. This gives for the first time a systematic historical review of the city from the time of its founding up to the present time, including its topographic history. The data are based upon published documents and non-published materials contained in various archives.

B. Geography—by Mag. Edg. Kant, with an introduction by A. Mieler on the geomorphology and hydrology of the location of the city. This geographic part of the work is done with such scientific thoroughness that it commands the close attention of students of geography, especially the geography of cities.

The visualization of the comparative growth of the population of the city through tonograms and the charting of the comparative time-length and the degree of intensity of sunshine and sunlight and the fluctuations of the temperature together with atmospheric pressure through a series of arithmograms are noteworthy.

For the above geographic part, its author, Mag. Edg. Kant, was awarded the Eduard Gaudy Medal by the Société de Geographie Commerciale de Paris in 1927.

C. General Part—24 chapters by 22 authors. This section gives a general picture of the present condition of the city as to population, architecture, industry, finance, education, and welfare work.

On the whole the work is a well-planned and well-executed study of the past and present of a city by modern scientific methods. It has attracted attention in a number of West-European countries. For instance, in Sweden it was made the subject of a study by the geography seminar in the University of Stockholm.

No such remarkable work was undertaken or attempted, or even conceived, in Estonia under the German or Russian régimes. Therefore, this work should also be considered as the demonstration of the intense ambition of the younger generation of scientific students in a state newly formed since the World War to gain notice and appreciation outside of their own hitherto obscure group.

PETER A. SPEEK.

Verrill, A. Hyatt. *Old Civilizations of the New World.* v and 393 pp.; illustrations, bibliography, index. The Bobbs-Merrill Company, Indianapolis, 1929.

Old Civilizations of the New World by the very versatile A. Hyatt Verrill is a discussion of the more popular phases of the archeology and ethnology of the new world. The book is written with the aim of making a general summary of the highlights of the great civilizations and cultures of America, some of which are even older than those of Egypt. *Old Civilizations of the New World* is written in a fascinating style with scientific skill and accuracy and yet the personal element is largely lacking. One can hardly believe that the author has travelled over sixty-six thousand miles in the collection of materials for his book. The book is intended for an introduction to the subject written primarily for the general public.

The book is about 400 pages in length; it has 56 illustrations and many sketches. As a special feature the book contains some of the best known and most popular Incan music, which has been rearranged for conventional instruments and has been previously published in Peru.

The first five chapters summarize the prevailing theories of the origin of life in America, the early cultural developments and their influences on man, and the mysterious problems of early civilizations. The conflicting theories of the origin of man in America are ably summarized with attempts to analyze and to correlate them. One theory maintains that ancestors of Indians reached America by way of Greenland. Another theory quite commonly accepted deals with the passage of Asiatics to America by way of Bering Strait. Other theories have tried to prove the descent of the Indian from the Norse Vikings, the lost tribes of Israel, or the inhabitants of a "lost" mid-Pacific continent. The author suggests that the ancestors of the Indians may be from more than one source. Thus, the Pacific coast tribes may have originated in the mid-Pacific islands or Oceania. Other peoples may have come across Bering Strait. Others by way of Greenland, and still others by way of southern Europe. These migrants may have found man in America and the resulting intermingling may have produced the wide diversity of types and tribes of America. In the remaining nine chapters the author gives a detailed discussion of the most important early civilizations giving a picture of these peoples as they really lived as gleaned from all possible existing records. Some of the people described are the Aztecs, the Toltecs, the Mayas, the Incans, and the Pre-Incans. The chapter on Coclé culture is based upon the author's discoveries in Panama in 1924 and is, of course, the most original and most thorough part of the work. Coclé culture is believed by the author to be the oldest of known advanced cultures in Central or South America.

The scope of the book is very broad. Volumes have been written upon the subject matter here outlined in a single chapter. Many books have been written on the Mayas alone while the discussion here is condensed into 60 pages. The same is true in the case of the Incans. The author has attempted, however, to give the broad general picture with greatest emphasis on the sections with which he is the most familiar. This is certainly justifiable in the case of an introductory book.

The book is of interest to the general public, and to the historian and the geographer. To the historian it will give a general background of the early civilizations of America without the technical language which hampers those not familiar with archeology and ethnology. To the geographer it suggests manifold and varied problems in the influence of environment upon early mankind. The author shows that climatic, meteorological, and geographical factors exert a tremendous influence upon cultural development controlling the type of utensils, implements, and weapons necessary for successful existence and the gradual development of culture. Tribal cultures vary greatly from forest environment to open plain environment. The author forcibly suggests a physiographic or perhaps a climatic change which has altered once prosperous civilizations to dreary wastes. An example of this is found in the case of Tiahuánaco or dead city which is located far up in the heights of the Andes a few miles from the shores of Lake Titicaca which is believed to have receded and caused the desertion of the city.

Elizabeth Gregory.

Miller, W. J. *Introduction to Historical Geology.* xvii and 438 pages; maps, drawings, illustrations. Third edition. D. Van Nostrand Company, 8 Warren Street, New York City.

The author, in his earlier editions, set himself to the task of presenting a résumé of geological history in such manner as to hold the interest of young college students or other intelligent readers. That he was successful was evidenced by the continued favor in which they were received during the past fifteen years. The changes necessitated by further researches and new discoveries have been important, yet in most respects they have not been revolutionary. This new edition, therefore, although completely rewritten, represents rather a refinement than a revision of the earlier works. The same systematic outline for each of the eras and periods has been followed, and students will have little difficulty in tracing the important evolutions of land forms and life forms because of the simple language and the systematic sequence in which they have been stated.

Recent discoveries bearing upon the age of the earth and the duration of each of the geological periods are given in relatively ample detail, necessarily brief, however, because of the space limitations placed upon the size of the book. The principal hypotheses of the origin of the earth are summarized with the chief points in favor of each as well as the objections stated clearly, and without adding any confusing notes the student is led deftly to realize at the outset that this problem is too great for hasty solution.

The clarity with which the evolution of life through the ages is presented is the strongest feature of the book; this should be expected perhaps. The paleogeography is subordinated as is also the economic aspects of the beds of the various geological ages. In a brief treatment some phases only can be emphasized and Professor Miller has chosen to emphasize the geological story of organic evolution. But since in his discussion of North America he relates many events and forms to definite localities, particularly in the United States, and refers to them by physiographic regions, one wonders why he persists in using the same generalized and unsystematic physiographic map that he presented years ago. The physiographic subdivisions outlined by Fenneman's committee and published by the Association of American Geographers is surely much better!

Nels A. Bengtson.

Torgasheff, Boris P. *The Mineral Industry of the Far East.* 512 pp., 322 tables, 14 maps, bibliography. The Chali Company, Shanghai, China (6 Kiukiang Road). 1930.

In these days of international trade, it is not enough to study the resources of one country alone, for the utilization of any particular mineral deposit may be affected by the needs and production of neighboring areas. A favorable location or the presence of a dense population may lead to the development of deposits which under other circumstances might be worthless. This book is thus particularly valuable as a comparative study of the resources, production, and requirements of the countries of eastern Asia. The areas considered include China and Manchuria, Japan with Korea and Formosa, the Russian Far East, the Philippines, and Indo-China. There is also a survey of the world's mineral market.

Detailed information on the mineral industry of the Far East has been difficult to secure, and Mr. Torgasheff has presented a thorough and reliable study. The major emphasis of the book is economic. There are over 300 tables dealing with production, trade, and reserves compiled from hitherto scattered or unavailable sources and in most cases brought up to 1927. The information has been gathered directly from government agencies and private operators and has been carefully checked. The book forms an indispensable reference volume for students of the Far East and for all workers in economic geography.

The book is divided into five parts. The first deals with the eight countries or regions under consideration. For each area there are detailed tables of mineral production and an analysis of the reserves. Although Japan is probably the poorest of the countries in respect to her mineral wealth, she nevertheless leads the Far East in the value of mineral production per square mile, with an annual average of over $2,000. This may be compared with $1,660 for the United States and $200 for China. If, however, the production of mineral wealth be considered on a per capita basis, the Russian Far East is first with $16 per year, while Japan has $4 and China but 85¢ per person, in comparison with $50 for the United States. Torgasheff considers that the Russian Far East, North Manchuria, Korea, and Indo-China are the most highly mineralized areas and that with suitable political conditions mining should develop rapidly. China proper has a considerable variety of metals, but aside from coal, the country appears to be entirely without large reserves.

The metals, non-metals, and fuels make up the next three sections. The occurrence and production of some sixty minerals are discussed in detail, with references to the companies, statistics of output, and the situation in world trade. The Far East is already an important source of minerals, producing 87 per cent of the world's antimony, 62 per cent of the tungsten, 30 per cent of the talc, 30 per cent of the kaolin, 24 per cent of the abrasives, 16 per cent of the arsenic, 16 per cent of the graphite, 14 per cent of the salt, 13 per cent of the magnesite, and 11 per cent of the pyrite. Other items of world importance are mercury, gold, feldspar, molybdenum, cement, bismuth, and tin. Coal is the most valuable product and the output is adequate for the present needs, with very large reserves in sight. In the case of iron and steel, however, the actual output is but one-sixth of the Far Eastern consumption. Herein lies the greatest metallurgical problem of eastern Asia, for the entire area is credited with but 3 per cent of the known iron ore reserves of the world. Since the present rate of consumption per capita is very low, there is hardly any danger of an iron famine for a century. The Philippine Islands and China lead in iron ore reserves, but in both cases the quality is poor.

The fifth part of the book is devoted to the economic factors of production and to world statistics of output and market prices.

The book is privately published in China and is not as creditable a piece of printing as can be done in that country. Unfortunately, there is no index, but there is a good bibliography.

GEORGE B. CRESSEY.

Angell, James W. *The Recovery of Germany.* 425 pages, Appendices, and Index. Published for the Council on Foreign Relations by the Yale University Press, New Haven. 1929.

The Recovery of Germany is an economic study made under the joint auspices of the Council of Foreign Relations and the Columbia University Council for Research in the Social Sciences. It is the outcome of the study and travel in Germany during the year 1928–1929, and is based on information gathered from conversation with many people in public and in private life, from personal observation made in the course of visits to over fifty factories and mines, and from statistical material.

As a foundation for the remainder of the book, eighty pages are given over to a concise but interesting review of the outstanding events between 1914 and 1924. Then by comparing and contrasting conditions in 1928 with those of 1913, the author indicates the progress that has been made in the six principal branches of German industry, the contrast that exists between the economic conditions of the industries and the people as a whole, and the trend of foreign trade; then after briefly outlining the outstanding features of the Young Plan points out the strength and the weaknesses of the nation as a whole, and makes some predictions as to the future.

The branches of German industry here analyzed—the coal, the iron and steel, the machinery, the electro-technical, the chemical, and the textile—employ nearly one-third of all the workers in industry, produce 40 per cent of the total manufactured products of the country, and 50 per cent of the total exports. In spite of the fact that one-third of Germany's coal reserves were ceded to France and Poland, she is now producing 85 per cent as much as she did in 1913, and is producing 9 per cent more than she did within her present boundaries in 1913. Although nearly three-fourths of her iron reserves, in addition to 20 per cent of her iron and steel working plants, were likewise lost, her present production is 80 per cent of what it was in 1913, and 15 per cent more than it was within her present boundaries at that time. Technically the German machine industry is in as good a condition as that of any other country in Europe, but financially it is not so satisfactory; a survey made in 1925 indicates that many of the firms were then earning only 1.4 per cent on the invested capital; since then business has improved somewhat and the average earnings probably run from 4 to 5 per cent. On the other hand the electro-technical industry is now one of the most prosperous industries in Germany, and the two big combines—the Siemens and the Allgemeine Elektrizitats-Gesellschaft—are paying from 8 to 14 per cent dividends. Similar rapid progress has been made by the chemical industry, and Germany is again one of the world's greatest exporters of chemical products, but instead of centering around coal tar products as it did before the war, the largest branch of the industry is engaged in the production of synthetic nitrate, chiefly the nitrate fertilizers. In contrast to the preceding industries, the textile industry which is by far the largest single industry in Germany—with the exception of the artificial silk branch—is as yet technically inferior to those of England and America although the financial condition as a whole is probably better than that in either England or America.

During this period of reorganization and progress of industry, agricultural production has been on the decline, and the physical volume of products is now, on the average, about 14 per cent less than it was within the present area in 1913. Nor has the improvement of the living conditions of the laboring people been as great as might be expected in comparison to the improvement in industry. For labor in general, the average real wage was about 6 per cent higher in 1928 than in 1913. Unemployment, on an average, between 1924 and 1928, was 6 per cent greater than in the four years preceding the war. A somewhat similar situation exists as to her foreign commerce. Her share in world trade in 1928 was 9 per cent, as compared with 13 per cent in 1913; her exports in 1928 were only 19 per cent of her aggregate production in comparison to 25 per cent in 1913.

In considering Germany's future, among the elements of strength that Dr. Angell has listed are the possession of the largest coal reserves of any continental country, a laboring population whose willingness to work is unsurpassed, and the thorough reconstruction and reorganization of the basic industries; among the weaknesses are the failure to pass on to the ultimate consumer more of the gains made by the improvement of industry, the heavy cost of government, and above all the persistent depression of agriculture. After a careful analysis of the conflicting sets of elements, the conclusion is that Germany's expansion in industry will continue at a less spectacular rate than it has since 1924 but that it will be none the less genuine, and that in time Germany will again attain national strength and prosperity.

MARTHA ROBINS.

ANNOUNCEMENT

THE series on the *Agricultural Regions of the World* will be resumed in the January, 1931, issue with the first instalment of *Agricultural Regions of Asia* by Dr. Samuel Van Valkenburg of the College of the City of Detroit. Another instalment of *Agricultural Regions of North America* by Dr. O. E. Baker will also appear in the January issue. This will be followed in a later issue by *Agricultural Regions of Africa* by Homer L. Shantz, President of the University of Arizona, and will complete the finest geographic discussion of the world's agriculture thus far published.

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In addition to this series of articles on agriculture, other series are being initiated; every issue will also contain four or five articles dealing with urban and regional geography, with problems of land utilization, with programs of development of resources, with commerce, with transportation, with health, and with the hundred and one other subjects that are of present geographic interest, all by the most competent and best informed authorities in their respective fields. ECONOMIC GEOGRAPHY is indispensable to the intelligent citizen.

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The July issue of Volume 6 contains the following articles:

Agricultural Regions of Australia, Griffith Taylor, University of Chicago.
The Pastoral and Agricultural Industries of Kenya Colony and Protectorate, Earl C. Case, University of Cincinnati.
Economic Adjustments in Bavaria, Hubert A. Bauer, University of Washington.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.
The Forest of Dean in Gloucestershire, E. Muriel Poggi, University of Illinois.

April includes:

Agricultural Regions of Australia, Griffith Taylor, University of Chicago.
Cane-Sugar Production in the British Empire, C. J. Robertson, St. Mary's Training College, Middlesex, England.
Rainfall and Wind Conditions Retarding Tropical Development, Stephen S. Visher, Indiana University.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.
Land Values in the Blue Grass and Nashville Basins, Raymond E. Murphy, University of Wisconsin.

January includes:

Agricultural Regions of South America, Clarence F. Jones, Clark University.
The Potato Industry in Nebraska, Esther S. Anderson, University of Nebraska.
Agriculture in the Dry Region of the U.S.S.R., N. M. Tulaikov, Agricultural Experiment Station, Saratov.
The German Sugar Beet Industry, E. Muriel Poggi, University of Illinois.
Divisions of the Pine Forest Belt of East Texas, William T. Chambers, Stephen F. Austin State Teachers College.

The October issue of Volume 5 contains the following articles:

Geography's Part in the Plant Cost of Iron and Steel Production at Pittsburgh, Chicago, and Birmingham, Langdon White, Randolph-Macon Woman's College.
Readjustments in Post-War Cotton Culture, Earl C. Case, University of Cincinnati.
Tung Oil: Florida's Infant Industry, M. Ogden Phillips, Formerly, University of Florida.
The Farm Problem, Robert Stewart, University of Nevada.
Forest Regeneration in Porto Rico, William D. Durland, Formerly, University of Porto Rico.
The Topographic Map of the United States, Guy Elliott Mitchell, U. S. Geological Survey.
Agricultural Regions of South America, Clarence F. Jones, Clark University.

July includes:

Canada's Advance to Hudson Bay, Harold S. Patton, University of Cincinnati.
Economic Conditions in St. Vincent, B. W. I., G. Wright, Imperial College of Tropical Agriculture, Trinidad.
Economic Geography of the Hawaiian Islands, Otis W. Freeman, State Normal School, Cheney, Washington.
Agricultural Regions of South America, Clarence F. Jones, Clark University.
Iron and Steel Industry of the Cleveland District, John B. Appleton, University of Illinois.

April includes:

Agricultural Regions of South America, Clarence F. Jones, Clark University.
The Potash Industry of Europe, Fred S. Mohme, University of Illinois.
The Sugar Industry of the British West Indies and British Guiana with Special Reference to Trinidad, C. Y. Shephard, Imperial College of Tropical Agriculture.
Iron and Steel Industry of the Middlesbrough District, John W. Frey, University of Wisconsin.
The Grape Industry of Spain and Portugal, W. O. Blanchard, University of Illinois, and Elizabeth R. Blanchard.
The Philippine Lumber Industry, Luis J. Borja.

Single copies of back numbers of Volumes 1 and 2, 1925 and 1926, will be sent to any American address for $1.75 each; to any foreign address for $2.00. Back numbers of Volume 3, 1927, Volume 4, 1928, Volume 5, 1929, and Volume 6, 1930, will be sent to any American address for $1.50 each; to any foreign address for $1.75. Whole volumes may be obtained at the yearly rate.

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